VOL. 32, NO. 4 APRIL, 1955

AMERICAN JOURNAL OF OPTOMETRY *and* ARCHIVES *of* AMERICAN ACADEMY OF OPTOMETRY

EDITOR
CAREL C. KOCH

EDITORIAL COUNCIL
KENNETH B. STODDARD
Chairman
ROBERT E. BANNON
IRVIN M. BORISH
PAUL L. CONNOLLY
RUDOLPH EHRENBERG
V. J. ELLERBROCK
ISIDORE FINKELSTEIN
HAROLD M. FISHER
EUGENE FREEMAN
GLENN A. FRY
MONROE J. HIRSCH
HENRY W. HOFSTETTER
D. G. HUMMEL
BERNARD MAZOW
O. L. MCCULLOCH
MEREDITH W. MORGAN, JR.
HERMAN SAGER

CONTENTS

ORIGINAL PAPERS

The Reliability of Clinical Measurements with Special Reference to Distance Heterophoria. *Meredith W. Morgan, Jr.* 167

Myopes Versus Nonmyopes—A Comparison. *Francis A. Young* 180

Progress Report of Partially Blind Cases. *I. Irving Vics* 192

The Relationship Between Accommodation and Accommodative Convergence. *Gerald Westheimer* 206

ANNOUNCEMENT

Plastic Washable Nearpoint Test Card 179

EDITORIALS

Academy Post-Graduate Courses. *V. J. Ellerbrock* 213

The Results of Mischief-Making in the Eye Field. *Carel C. Koch* 216

TRANSACTIONS OF THE ACADEMY

Academy Luncheon at Milwaukee 217

Chapter Activities 217

CURRENT COMMENTS

Hennepin County Welfare Board Fee Schedule. *Terry Judith Parkins* 218-222

Published Monthly by the AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION, 1502 Foshay Tower, 821 Marquette Ave., Minneapolis 2, Minn.

ANNUAL SUBSCRIPTION, UNITED STATES and CANADA $6.00. FOREIGN $6.50.
Single copies, 60c

Entered as second-class matter, February 20, 1934, at the post office at Minneapolis 2, Minnesota, under the Act of March 3, 1879
Established 1924

The Most Important Screw in a Spectacle Frame is a

Loose Screw!

In a combination frame, between a safe and sound lens and a broken one lies but one tiny screw. Tight, it seldom is noticed. Loose, it becomes a hazard and a potential waster of time, money and good will, the most vital screw in the whole frame.

Most optical men have been victims of the loose screw nuisance. They've had to pacify patients, spend time on adjustments, even replace some broken lenses without cost.

Wonderfully opportune, then, and widely welcomed, is Continental's new MANSFRAM with its Barreloc construction. In Barreloc, ingenious little tubes soldered to the frame eyewires have metal ears which turn down over the screw heads to lock them securely into place. It ends a world of woes.

MANSFRAM with Barreloc is now in the hands of most independent laboratories. If you haven't seen it, do. Use it and enjoy the pleasure it gives patients, the freedom from problems it gives you.

Continental

INDIANAPOLIS

AMERICAN ACADEMY OF OPTOMETRY

Dr. John D. Perry, Jr., *President*
Winston-Salem, North Carolina

Dr. R. W. Tubesing, *Vice-President*
Richmond, Indiana

Dr. Carel C. Koch, *Secretary*
Minneapolis, Minnesota

EXECUTIVE COUNCIL

Dr. John D. Perry, Jr., *Chairman*
Winston-Salem, North Carolina
Dr. R. W. Tubesing, *Vice-Chairman*
Richmond, Indiana
Dr. Carel C. Koch, *Secretary*
Minneapolis, Minnesota
Dr. Meredith W. Morgan, Jr., *Past President*
Berkeley, California
Dr. Lawrence Fitch
Philadelphia, Pennsylvania
Dr. J. Donald Kratz
Souderton, Pennsylvania
Dr. Donald A. Springer
Anniston, Alabama
Dr. Ralph E. Wick
Rapid City, South Dakota

EX OFFICIO MEMBERS

Dr. Harold Simmerman
Wenonah, New Jersey

Dr. Kenneth B. Stoddard
Berkeley, California

SECTIONS OF THE ACADEMY

SECTION ON ANISEIKONIA

Dr. Oscar L. McCulloch
Chairman
Holyoke, Mass.
Dr. Robert E. Bannon
Southbridge, Mass.
Dr. E. W. Bechtold
New York, N. Y.
Dr. G. M. Belanger
Ottawa, Ont.
Dr. Benton Freeman
Allentown, Pa.
Dr. Harold Fisher
New York, N. Y.
Vineland, N. J.

CONTACT LENS SECTION

Dr. Bernard Mazow
Chairman
Houston, Texas
Dr. Eugene Freeman
Chicago, Ill.
Dr. Robert C. Graham
Pasadena, Calif.
Dr. John C. Neill
Philadelphia, Pa.
Dr. Wm. W. Policoff
Wilkes-Barre, Pa.
Dr. S. G. Weiss
Torrington, Conn.

SECTION ON PATHOLOGY

Dr. Monroe J. Hirsch
Chairman
Ojai, Calif.
Dr. Jay Enoch
Columbus, Ohio
Dr. David D. Michaels
Chicago, Ill.
Dr. Harold Simmerman
Wenonah, N. J.
Dr. Rita Walsh
Bloomington, Ill.
Dr. Henry L. Wolfe
Marshalltown, Iowa

SECTION OF OCCUPATIONAL OPTOMETRY

Dr. Herman Sager, *Chairman*
Lake Success, N. Y.

Dr. Richard Feinberg
Chicago, Ill.
Dr. Sylvester K. Guth
Cleveland, Ohio
Dr. Richard M. Hall
Cleveland, Ohio
Dr. Henry B. Peters
Oakland, Calif.
Comdr. J. H. Steeve
Washington, D. C.
Dr. Edward Steinberg
New York, N. Y.

SECTION ON ORTHOPTICS

Dr. Paul L. Connolly
Chairman
Detroit, Mich.
Dr. Merton C. Hom
Berkeley, Calif.
Dr. H. L. Haines
Columbus, Ohio
Dr. I. W. Kinsey
Alliance, Ohio
Dr. T. R. Murroughs
Evanston, Ill.
Dr. J. I. Pascal
New York, N. Y.
Dr. Max Schapero
Los Angeles, Calif.
Dr. Daniel Woolf
New York, N. Y.
Dr. John Zettel
Cincinnati, Ohio

Office: American Academy of Optometry: 1502 Foshay Tower, Minneapolis 2, Minn.

The AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY serves as the official publication of the American Academy of Optometry. It is published monthly by the American Journal of Optometry Publishing Association under the editorial supervision of the American Academy of Optometry.

Publication Office: 1502 Foshay Tower, 821 Marquette Ave., Minneapolis 2, Minn.

millions of lines of "plural pairs" publicity

Bausch & Lomb initiated this program in 1952. Coast-to-coast and border-to-border, feature stories, news items, health and fashion tips—keep appearing in newspapers, magazines, on radio and TV for millions of people to absorb.

Visual Needs Analysis for immediate results

Just introduced—but already, there has been enthusiastic endorsement of VNA and recommended procedures. VNA is a logical, easy approach to the discussion of the patient's multiple visual needs.

FREE! **If you missed our recent offer of a trial quantity of VNA forms, write your name and address on a post card with the letters VNA. Mail to Bausch & Lomb Optical Co., Dept. F-064, Rochester 2, N. Y.**

complete patient satisfaction at point of prescription

Now! A lovely boudoir case for women and a handsome zippered leatherette case for men dramatize "plural pairs" idea! Ideal as accessories for patients' use—perfect as demonstration piece for fitting room.

3 ways B&L helps you say:

"One pair of glasses is not enough"

Bausch & Lomb has been at work persistently to indoctrinate a vast public with the plural pairs concept. Patients *want* the added visual comfort, the efficiency and pleasure of additional pairs *when they understand the facts.*

To help you serve your patients, Bausch & Lomb offers Visual Needs Analysis and cases for patients' various eyewear needs—practical tools for demonstration and discussion of additional pairs to meet all visual needs for function and fashion.

Plan now to adapt them to your procedures. No amount of mass educational effort will take the place of face-to-face discussion of plural pairs benefits by you—the professional man.

BVI

BAUSCH & LOMB

SINCE B&L 1853

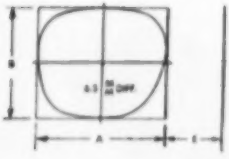
Your supply house representative will explain Bausch & Lomb Visual Needs Analysis and show you the new cases. He'll be calling soon from the B&L. Independent or the B&L. Branch in your area.

FOR TODAY'S MEN...

THE *Clarbridge* TOWNSMAN

Your patient—executive or sportsman, or both, will cheer the versatility of the Clarbridge Townsman . . . an all-occasion frame for men of today! Here is a frame—strong, firm, distinctively masculine and made with the famous 7-barrel hinge . . . plus, of course, all those unmatched Art-Craft features for easy, sure adjustment and fit.

MEASUREMENT CHART FOR TOWNSMAN ZYL FRAME



EYE	A	B	E BRIDGE
40	41	34.5	20-22-24
42	43	36.5	20-22-24
44	45	38.5	20-22-24-26
46	47	40.5	20-22-24-26

P. D. – A + E 43 + 20 – 63 P. D.

Available with No. 8 Skull Temples only

Sizes:
3¾, 4, 4¼, 4½, 4¾, 5
Length to bend

Colors Black on Crystal, Cadet Blue on Crystal, Mocha on Crystal, Wine on Crystal.

MANUFACTURER • **ART-CRAFT OPTICAL CO. INC.** 89 ALLEN STREET ROCHESTER 6, N. Y.

• DISTRIBUTED BY •

ART CRAFT OPTICAL OF NEW YORK CITY, INC.
ART CRAFT OPTICAL OF PHILADELPHIA, INC.
ART CRAFT OPTICAL OF CHICAGO, INC.
ART CRAFT OPTICAL OF NEW ENGLAND, INC.
ART CRAFT OPTICAL-MIDWEST, INC.
ART CRAFT OPTICAL-SOUTHEAST, INC.
ART CRAFT OPTICAL-WEST COAST, INC.
ART CRAFT OPTICAL OF THE SOUTH, INC.
ART CRAFT OPTICAL-NORTH CENTRAL, INC.
ART CRAFT OPTICAL OF ROCHESTER, INC.
ART CRAFT OPTICAL-MIDDLE ATLANTIC, INC.
ART CRAFT OPTICAL-SOUTHWEST, INC.
ART CRAFT OPTICAL OF CANADA, LTD.
ART CRAFT OPTICAL-INTERAMERICANA, INC.
ART CRAFT OPTICAL EXPORT CORP.

BVI

GLAMOUR WITH A SPARKLE

Ladybrow JEWELETTE

Exclusive No. 9 Jewelette Trim . . . stunningly fashioned in a new and modern design of a sweeping dart piercing a crescent with handset Austrian stones. Also available plain without stones as "Ladybrow De-Lite" with No. 1 De-Lite Trim.

Catalog No. 400 by Universal

Ladybrow . . . at last, a new and glamourizing combination frame for women!

Time to change to *Ladybrow*

with its new top line

new bridge treatment . . . new eye shape

new raised endpiece

the latest in perfection manufacture

of combination frames.

Modern, fashionable colors: SABLE • BRONZE • SLATE • EBONY • BRIAR
Also available with No. 40 Empire Temples, 1/10 12K Gold Filled.

Ask your supplier for samples now

SIZES 7 m/m DIFF.

EYE	BOX MEASUREMENT	BRIDGE
40	(41.5 x 34.5)	18, 20, 22
42	(43.5 x 36.5)	18, 20, 22, 24
44	(45.5 x 38.5)	18, 20, 22, 24
46	(47.5 x 40.5)	18, 20, 22, 24

For the Finest Fashions in Sight . . . . . Look to

Universal OPTICAL COMPANY

72 WEYBOSSET ST., PROVIDENCE 3, R. I.

Offices: Los Angeles Atlanta

Jack Pot for Everybody's Good

But only a handful of manufacturers pay the major share of the bill . . . as they always have.

But what about the *free riders? You* make them possible if you support them.

Isn't it common sense and better professional ethics to *support those who support you?* What better proof of loyalty? What surer contribution to future security? You cannot *squawk* for big-time publicity, and *balk* on your obligations.

And when you come right down to it, buying on a penny-pinching basis from nondescript, non-paying firms only *gets* you pennies. Supporting those who put up the money for a big-time public relations program will get you *dollars* by increasing your income and prestige.

The chips are down, brother! What do you say?

Better Vision Institute, Inc. 630 Fifth Avenue, New York 20, N. Y.

Sticking Together Multiplies Our Strength

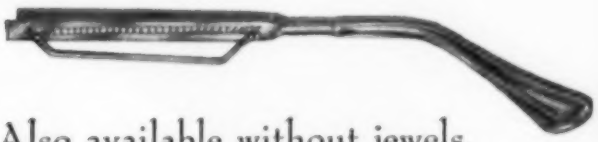
Glamour JEWEL TEMPLE

...a titmus original

Will fit all frames, both metal and zyl, using five barrel butt end hinges.

T-21 White Gold, T-22 Yellow Gold — 1/10 12K. G. F.

a new French design!



Also available without jewels.

T-23, White Gold, T-24 Yellow Gold — 1/10 12K. G. F.

Titmus OPTICAL COMPANY, INC.

Manufacturers of Ophthalmic Lenses, Frames, Sun Glasses • Petersburg, Virginia

Colonial Grain, Dual-Tone

The Flame

Colonial Grain, Solid Color

American Optical

Every Fine Frame
Deserves a
Quality **AO** Case
dual-tones and
solid colors

Horsehide Grain, Solid Color

Inevitably, your patients associate the quality of the case you give them with the quality of your service and materials. That's why this small but important detail deserves to be a quality *AO* case.

Its slight extra size makes the Hinge-Craft No. 50 ideal for the new Flame frames, either with comfort cable or with contour tip temples.

Fine coverings in solid color Horsehide Grain or Colonial Grain in solid colors or dual-tone give it a style appeal women appreciate.

These handsome coverings add the last touch to fine patient relations. Ask your AO Representative to show you samples and swatches for Hinge-Craft No. 50.

T. M. REG. BY AMERICAN OPTICAL COMPANY

positive PROTECTION

Now that vacation time is here, millions of people will need eye protection from the intense rays of the summer sun. Many of these people will read about the superior qualities of AO Cosmetan Sun Glasses in ads in Holiday, Time and Sports Illustrated.

For all of your sun glass patients, AO Tillyer Rx Cosmetan offers new visual comfort and protection.

AO Cosmetan absorbs 99% of undesirable ultraviolet (sunburn) . . . over 85% of infrared (heat) rays . . . transmits only 21% of visible light . . . and reduces reflected glare. And — Cosmetan's high blue absorption qualities provide sharp object definition even under hazy atmospheric conditions.

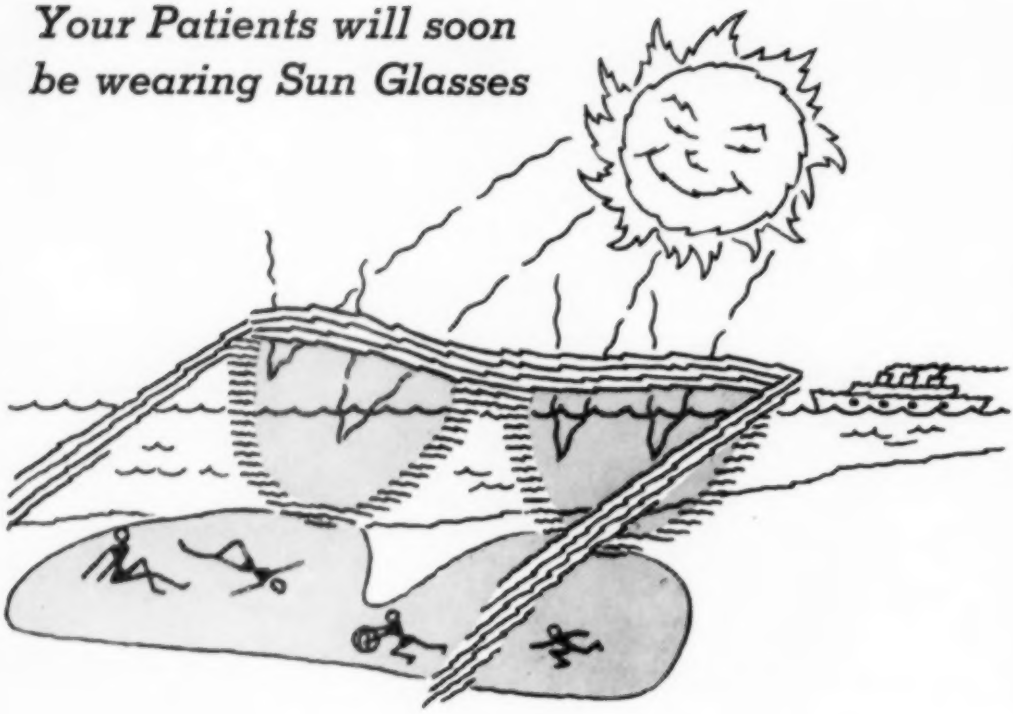
It's the ideal sun glass not only in the summer, but all year 'round.

AO Rx Cosmetan is available in Tillyer Single Vision, Tillyer Ful-Vue "C", Tillyer Ful-Vue "S", and Tillyer "D" Bifocals; also in plano sun glasses.

American Optical

from the sun's rays

Your Patients will soon be wearing Sun Glasses



Be ready for them — anticipate their needs before they come to you. Let your BENSON representative show you what we believe to be the most complete selection of sun glasses in the field.

He'll be able to supply **G15** in bifocals and trifocals, and single vision in uniform density . . . **Bifocals and trifocals** of your choice in **greens 2 and 3** in regular size as well as **LARGE** sun glass size . . . And, in addition, a full line of the popular **AO CALOBARS** and **B & L RAY-BANS** . . . plus *hundreds* of beautifully laminated **frames** (plain or with precious metal trim) in plano and prescription form.

If the BENSON *sales representative misses you, inquire at any* BENSON LABORATORY *about the complete line of* BENSON *sun glasses.*

Since 1913 **Benson** OPTICAL COMPANY *Executive Offices • Minneapolis 2, Minn.*

COMPLETE LABORATORIES CONVENIENTLY LOCATED IN UPPER MIDWEST CITIES

AMERICAN JOURNAL OF OPTOMETRY
and ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY

Vol. 32 April, 1955 No. 4

THE RELIABILITY OF CLINICAL MEASUREMENTS WITH SPECIAL REFERENCE TO DISTANCE HETEROPHORIA*

Meredith W. Morgan, Jr.†
School of Optometry, University of California
Berkeley, California

A routine refraction consists of a series of measurements of complex psycho-physiologic functions. As a rule, a single number is recorded for each test made which is supposed to represent, in a quantitative way, each particular function. The datum recorded is assumed to be of some value, otherwise there would be no point in taking the time to make the measurement. If the measurement is at all useful, it must be accurate or if it is not exactly accurate the possible error should be known. A measurement whose accuracy is completely unknown has no use whatever. It is therefore necessary to know how to estimate the reliability of a datum. The departure of the measurement from the real value has been termed the error of measurement. There are many types of errors of measurement.

Systematic errors are the same for each observation with the same instrument and method or they are some definite function of the value of the quantity observed. This is the type of error one would make if a Risely prism, for example, were incorrectly calibrated or if the gears in the prism control were worn. This type of error is more easily noted than most errors since, as its name implies, the error has a rather definite value and is present in each and every similar measurement. For example, suppose a refractionist, using the Jackson Cross Cylinder method for determining the axis of the correction cylinder, finds a great many subjects require the axis of the correcting cylinder at 10° and very few subjects require the axis at 180°. This is contrary to experience. This refractionist might naturally investigate the position of the cylinder bank or cell in his phoropter or trial frame at axis 10°. It is most likely that when the device reads 10° the real axis is 180°.

Personal errors are of two types, one involving the patient and the other the examiner. The errors involving the patient can run from

*Read before the annual meeting of the American Academy of Optometry, Toronto, Ontario, Canada, December 13, 1954. For publication in the April, 1955, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
†Optometrist, Ph.D., Member of faculty, Fellow, American Academy of Optometry.

not understanding what is required of him to just being an honest but poor observer. Patient errors are very difficult to detect on a single measurement but an astute clinician can usually tell after three or four different tests that there is something wrong. On single measurements, however, the patient may make an error that will go undetected. Sometimes this patient error is merely slowness in response. This will mean, say on determining a blur point, that the reading recorded is too high. On the other hand, the patient may anticipate the blur in his eagerness to detect it and in this case the measurement will be too low.

The same sort of errors are made by examiners as are made by subjects. In addition, there are the errors of prejudice. Prejudice may be as simple as the reading of instruments to the nearest even number, or to the nearest odd number. For example in a series of measurements by Rosen reported by Manas and Shulman[1] there are 120 separate measurements of the heterophoria of an individual under three separate conditions (40 in each condition). Of these measurements 101 are even. This probably resulted from the fact that the Risely prism used was calibrated in 2△ steps. However, regardless of the cause, it does mean that the examiner was reading the prism scale in such a way that each datum point might be in error ±1△ as a minimum.

Another type of prejudice is the bias that can creep in if the meaning of the readings can be directly interpreted by the examiner in terms of a theory in which he believes or disbelieves. Persons of the highest integrity will often unconsciously read a little high or a little low from this cause.

Mistakes are obvious errors that all make. These are the errors of arithmetic, misplacement of a decimal point, reversal of sign, transposition of figures, recording incorrectly, reading a scale backward, etc.

Random errors are the variations due to the working of a number of uncontrolled variables, each of whose effects is individually small. It is generally assumed that the variables causing random errors change their numerical value and even the sign (positive or negative) of their effect independently of each other.

In laboratory, as contrasted to clinical, measurements of different visual functions, attempts are made to make the errors of measurement as small as possible by means which cannot be applied clinically. This is accomplished by using instruments whose accuracy has been critically checked, by using only trained observers, by using at least two examiners to check each other, or by making the same measurement on different occasions, and by taking a number of measurements of the particular function of interest. Even under these ideal conditions the

same answer is not found for each measurement. One generally must be satisfied by determining the mean and the standard deviation of the measurements and then using these data to determine, by statistical inference, the probable limits of the true value of the measurement. In other words, random errors cannot be eliminated. This can be expressed mathematically

$$RM = TM + R \qquad (1)$$

This is to say that the recorded measurement is equal to the true measurement of the function plus random variation. R may have either a plus or a minus value.

In clinical measurement another error factor must be added to represent the other errors discussed. Thus each clinical measurement can be represented by the expression

$$RM = TM + R + E \qquad (2)$$

Here E is the sum of all errors which are not included in the term "random error." Again E, independently of R, may be either positive or negative.

Thus the variability of any measurement is represented by R + E for clinical tests and by R for laboratory measurements.

In order to make the data of any examination useful some idea of the probable value of R + E for each separate measurement must be known. The examiner should have confidence in his ability to detect the presence of absence of abnormality in the function being measured.

One method of estimating the value of R + E is to use the standard deviation of the same measurement as gained from past experience. Here one makes the assumption that a test made by an experienced examiner will have about the same standard deviation from individual to individual. Thus one might assume that any measurement made on an individual plus and minus one standard deviation of the same measurement made on a group of individuals in the past will include about 68% of all measurements made on this same individual.

Scobee and Green[2] report that they obtained standard deviations of $\pm 2.2\triangle$, $\pm 2.8\triangle$ and $\pm 1.9\triangle$ for the screen-parallax, the screen-Maddox rod, and the von Graefe methods, respectively, for the determination of the distance heterophoria on clinic subjects. The present author on a recent series of 100 measurements on one subject using the screen-Maddox Rod technique obtained a standard deviation of $\pm 2.2\triangle$.

This method of determining the variation merely states that if many successive measurements are made, 68% of the findings will be between the mean plus one standard deviation and the mean minus one standard deviation.

There are two basic weaknesses of this technique of determining R + E. First the assumption that a single, or at the most several, measurements of a function-like heterophoria will give a result which can be treated like the mean of many measurements and second that the standard deviation of a group can be applied without reservation to an individual.

Unfortunately the standard deviation for each of the measurements as applied to the population as a whole is not generally known. As a rule, optometric tests are applied to a pre-selected portion of the population: namely, those in the population who believe they are having a visual problem. This means that in most instances in which the standard deviation of a measurement is known it is the deviation in the population having visual problems. This is not necessarily a bad thing if the examiner keeps this in mind.

If many measurements of the function in question have been made on an individual, one can, of course, use the mean and the standard deviation determined from these data. However, here one can use to better advantage the standard error of measurement (this should not be confused with the standard error of the mean). Here the difference between one-half score and the other half score for the same person is a measure of the error for that individual. Since errors are conceived of as deviations, squaring, summing and dividing by N should estimate the amount of error variance. This can be represented by

$$S.E._{meas} = \frac{\Sigma d^2}{N} \qquad (3)$$

where d = difference between two scores of half tests for one individual such as between odd and even pools of items. Another technique that is sometimes used is to calculate the so-called coefficient of reliability. Here one measures the same function many times (usually more than 30) and then on a second occasion the measurements are repeated. The coefficient of correlation between the two sets of measurements is then determined. One can perform this test of reliability in many other ways than that suggested here. For example, one might make 100 measurements of the same function and then calculate the coefficient of correlation between the even numbered measurements and the odd numbered measurements.

Scobee and Green have used both of these methods in order to determine the errors of measurement (R + E) of the distance heterophoria. They found that the standard error of a single measurement of the heterophoria in their study on a group of aviation cadets to be 0.73 and the coefficient of reliability to be +0.95. They interpret

this to mean,[3] "A notion of the absolute accuracy with which heterophoria may be measured may be obtained from the standard errors of single determinations. For lateral heterophoria, the standard error is 0.73 which means, approximately, that a lateral heterophoria measurement may be in error by as much as 1.5△ (2 × 0.73)."

The coefficient of reliability and the standard error of measurement are related by

$$S.E._{meas} = S.D. \sqrt{1 - r_t} \qquad (4)$$

where $S.E._{meas}$ = the standard error of measurement, S. D. = the standard deviation of the distribution of obtained scores and r_t = the reliability coefficient.

In the study by the writer mentioned above, the standard error of measurement was ±0.53△ and the coefficient of reliability was 0.94.

It would appear then that the sum of the factors, R + E, is at least 1.00△ for the distance heterophoria. It should be noted that these data probably represent minimum values since the subjects used were selected subjects and not just run of the mill patients.

Aside from the necessity of knowing the value of R + E at any one testing time for all the measurements made in a refraction so that the data may be properly analyzed, it is also important to be able to compare the data obtained at some subsequent examination with that of a previous one. It is highly desirable that one be able to detect trends of deterioration or of improvement. This is epecially true when one desires to assess the value of some therapy such as the effect of a lens prescription or orthoptics. It would be highly desirable to be able to subtract directly one measurement from the other and to say the difference between the two measurements represents the change in function,

$$RM_2 - RM_1 = C \qquad (5)$$

where RM_1 = recorded measurement at the first examination, RM_2 = recorded measurement at the second, and C = the observed change. Unfortunately the errors of measurement already discussed (Formula 2) occur for both the first and second visit. Thus

$$RM_1 = TM_1 + R_1 + E_1 \qquad (6)$$

$$RM_2 = TM_2 + R_2 + E_2 \qquad (7)$$

and

$$(TM_2 + R_2 + E_2) - (TM_1 + R_1 + E_1) = C \qquad (8)$$

or

$$TM_2 - TM_1 = C + R_1 + E_1 - R_2 - E_2 \qquad (9)$$

We can, therefore, say that the difference between the true measurements at two examinations is not only represented by the observed change in the function, C, if any, but also includes the differences in the errors

of measurement. It cannot be assumed that these errors are the same in each case and thus cancel each other on subtraction. It could happen that errors should be added and not subtracted. For example, suppose that we found that a patient had 3△ of exophoria at the first visit and at some second visit after say orthoptics the patient now was measured as being orthophoric. One might be tempted to say that

$$RM_2 - RM_1 = C = O - (-3) = +3\triangle \quad (10)$$

the function had changed by 3△. Suppose though that

$$R_1 + E_1 = -1.5\triangle \quad (11)$$

and

$$R_2 + E_2 = +1.5\triangle \quad (12)$$

Then the true state of affairs would be

$$(TM_2 + 1.5) - (TM_1 - 1.5) = 3 \quad (13)$$

$$TM_2 - TM_1 + 3 = 3 \quad (14)$$

$$TM_2 - TM_1 = 0 \quad (15)$$

On the other hand, it could be that in each instance R + E had the same sign

$$R_1 + E_1 = +1.5 \quad (16)$$

$$R_2 + E_2 = +1.5 \quad (17)$$

then

$$(TM_2 + 1.5) - (TM_1 + 1.5) = 3 \quad (18)$$

$$TM_2 - TM_1 = 3 \quad (19)$$

In this case our clinical measurements would represent a real change in function. If, however,

$$R_1 + E_1 = +1.5 \quad (20)$$

$$R_2 + E_2 = -1.5 \quad (21)$$

then

$$(TM_2 - 1.5) - (TM_1 + 1.5) = 3 \quad (22)$$

$$TM_2 - TM_1 = 6 \quad (23)$$

Here our therapy would be even more effective than indicated by the clinical measurements.

For simplicity, it can be stated that

$$TM_2 - TM_1 = V \quad (24)$$

$$V = C + R_1 + E_1 - R_2 - E_2 \quad (25)$$

where V = true variation in the measurements.

Brozek and Simonson[4] have developed a method of determining the consistency of measurements when data on a group of individuals for a series of trials is known.

Very briefly their method involves the calculation of the standard deviation of the measurements on individuals and also a consistency coefficient which they have termed, r_c. The coefficient of consistency is

a modified coefficient of intraclass correlation and is closely related to the ordinary product-moment coefficient of correlation computed when only two repeated trials are available. It is similar to the coefficient of reliability mentioned above. It is dependent on two factors: 1. The variation between individuals and, 2. The random variation between individuals and trials.

The variation between individuals would ideally be expressed by the variance (standard deviation squared) of the scores in a large, representative sample of individuals for whom the test will be used. Such a variance value is a stable characteristic of each test and would provide a criterion in terms of which different tests could be legitimately compared. Unfortunately, this value is generally not known.

The best substitute is the "within trials" variance, which represents the interindividual variance obtained for each trial and averaged. This can be termed V_{wt}

$$V_{wt} = \frac{\sum_{1}^{k} \frac{\sum_{1}^{n} (Y_t - \bar{Y}_t)^2}{n - 1}}{k} \tag{26}$$

where k = number of trials
n = number of individuals
Y_t = individual score on a given trial
$\bar{Y}_t$ = the mean score of n individuals on that trial

The random variance can be represented by V_R

$$V_R = \frac{\sum_{1}^{nk} \left[Y - Y - (Y_i - Y) - (Y_t - Y) \right]^2}{(n - 1)(k - 1)} \tag{27}$$

where Y = a measurement
$\bar{Y}$ = grand mean of nk measurements
Y_i = mean of k measurements on an individual
$\bar{Y}_t$ = mean of n individuals on a trial

The consistency coefficient is then

$$r_c = 1 - \frac{V_R}{V_{wt}} \tag{28}$$

The r_c values usually vary from 0.60 to 0.81; in a reasonably heterogeneous group of subjects, values of r_c below 0.70 would be regarded as indicating low consistency of the scores on repeating testing.

$0.71 \leq r_c \leq 0.80$ would be interpreted as an index of moderately high consistency. If the consistency is high then the variation between trials or examinations is low and consequently any change in function, C must also be low. Also variations in the error of measurement must be low.

In order to test the consistency of the heterophoria determinations data gathered from various sources were examined and the consistency coefficient of Brozek and Simonson was calculated.

In 1951 the distance (6 meters) and near (40 cms.) heterophoria of 23 members of the class of 1952 of the University of California School of Optometry were measured each week for five weeks. The measurements were made alternately by two students serving as examiners for each student serving as a subject. The data were handed in each week and were not available for comparison purposes in the succeeding measurement. The distance heterophoria was determined by the screen-Maddox Rod method and the near heterophoria by the screen-von Grafe method. In Table I is the raw data for the distance heterophoria and in Table II the raw data for the near heterophoria. The calculated values are shown in Table III.

Another source of data in which there is available a series of measurements on the same subjects, is the Orthoptics Clinic. In the Fall of 1951 there were 17 patients who had their data checked at least five times during the semester. These determinations were independent of daily checks in the clinic. The distance heterophoria measurements for these subjects is shown in Table IV. In the column marked trial one are the data from the referring clinicians. Thus these data were gathered by many examiners. Trial two gives the data obtained on the first visit to the orthoptics laboratory while trial five gives the data at the time of discharge. Trials three and four give the data obtained during the training sessions. The mean, standard deviation, variance and consistency coefficient of this group is also shown in Table III.

Two factors should be pointed out with respect to this group before one compares these data to that given in Table I. First, the group is more diverse in that a wider variation in the heterophoria is represented. This will tend, of itself, to make the Value V_{wt} higher and consequently the value of r_c lower. Second, the group as a whole is exophoric.

In spite of the diverse nature of the group and the rather high heterophorias represented, the standard deviation of the group as a whole is rather low, $\pm 1.70\triangle$. The visual training given this group

TABLE I.

Subject	Trial 1	2	3	4	5
RBr	+4.0	+2.0	+5.5	+4.0	+2.0
RBU	—1.0	—1.5	—1.5	—1.0	—2.0
BC	0.0	0.0	—2.5	—2.0	—1.0
HC	—1.0	—1.0	—2.0	—2.5	—1.0
BF	—3.5	—4.0	—2.0	—2.5	—3.0
HGar	—1.0	—0.5	—2.0	—2.0	—1.5
HGay	—2.0	—1.5	—2.0	—2.0	—0.5
HGo	+2.5	+4.0	+2.5	+1.5	+3.0
FG	—1.0	—3.0	—4.0	—2.5	—2.0
RG	+1.0	+3.0	+2.0	+2.0	+4.0
RH	0.0	—0.5	—1.0	+0.5	+1.0
JL	—1.5	—0.5	—2.0	—1.0	—1.0
KL	—3.0	—2.0	—4.0	—1.5	—4.0
RM	—1.5	—2.0	—2.5	—1.0	—2.0
CN	—1.0	—1.0	—2.0	0.0	+1.0
MN	+1.0	+1.5	+1.0	+1.0	+1.5
RP	+1.0	+0.5	+0.5	+2.0	+1.0
AR	0.0	+2.0	+0.5	+0.5	—0.5
GR	—0.5	—1.5	—0.5	—1.0	+1.0
DS	—1.0	—2.0	0	+0.5	—1.0
SS	+4.0	+1.0	+2.0	+2.0	+5.0
ET	+0.5	—1.0	—1.0	—1.0	—1.5
SZ	—12.0	—8.0	—11.0	—9.0	—4.0

Heterophoria for 6 M fixation distance.

TABLE II.

Subject	Trials 1	2	3	4	5
RBr	+2	+3	—2	+1	+2
RBu	—7	—6.5	—8	—5	—7
BC	—4	—6	—3	—4	—6
HC	—14	—14	—13	—15	—13
BF	—10	—10	—7	—4	—9
HGar	—4	+0.5	0	—2.5	—3
MGay	—6	—10	—10	—7	—11
HGo	—2	—4	—4	—4	—1.5
FG	—2	—3.5	—4	—8.5	—4
RG	—3	—0.5	—2.5	+2	+4
RH	—3	—2	—5	—3	—2
JL	—3	—10	—5	—13	—14
KL	—4	—2.5	0	—5	—3
RM	—3	—0.5	—6	0	—1
CN	—3	—4	—2	—3	—5
MN	+3	—1	—2	—2	+1
RP	0	+0.5	0	+0.5	0
AR	—6	—4	—4	—4	—3
GR	—4.5	—5	—2	—5	—4
DS	+8	+9	+7	+9	+8
SS	+10	+2	+6	+4.5	+5
ET	+4	—11	—3	—2	+5
SZ	—18	—10	—14	—16	—16

Heterophoria for 40 cms. fixation distance.

TABLE III.

Description and source of subjects	Values calculated Mean	$S.D._{wt}$	V_{wt}	V_R	r_c	$S.E._m$
1. Distance phoria class of '52	+0.67	±1.13	+7.46	+1.22	0.84	±0.5
2. Near phoria class of '52	—3.50	±2.48	+32.89	+6.33	0.81	±1.0
3. 17 subjects receiving orthoptics	—3.4	±1.70	+33.61	+2.86	0.92	±0.5
4. 7 subjects seen 7 times	—0.15	±1.30	+13.11	+1.80	0.86	±0.5
5. 20 subjects seen 5 times	+0.91	±1.22	+5.02	+1.32	0.74	+0.6
6. 6 subjects wearing prisms	—4.73	±2.05	+7.85	+3.48	0.44	±1.4
7. Flom data	+0.98	±1.65	+8.77	+2.40	0.73	±0.8

Legend: Calculated results for the various groups of subjects described in the paper.

TABLE IV.

Subject	Trials 1	2	3	4	5
DB	—22	—18	—20	—21	—20
CC	0	+1	0	0	0
RD	+2	+2	+2	+4	+1
JF	+1.5	+1.0	+1.0	+1.0	+1.0
WH	—8	—9	—8	—8	—8
YJ	0	+1	+1	+6	+3
EL	0	0	+1	+1	+1
CM	0	+0.5	0	+1.5	+1.0
DM	0	—1	—6	—6	—7
CM	—2	+3	—1	0	0
NM	—11	—9	—8.5	—12	—7
HR	—8.5	—2.5	—2	—2	—1
CS	0	0	0	—3	—2
MT	—2	—4	—4	—5	—5
LT	—10	—10	—8	—8	—9
ST	—8	—8	—9	—8	—9
PZ	+1	+1.5	+1	+2	+1

Distance heterophoria of subjects receiving orthoptics.

did not change the heterophoria value but tended, on the contrary, to stabilize the value as can be seen by the high value of the coefficient of consistency. This could be interpreted to mean that the visual training that these subjects received made good observers of them and consequently the errors of measurement were decreased.

The fact that the heterophoria shows a marked consistency in this group should not be taken to mean that the visual training was not effective. Before one can determine the efficacy of the training these subjects received, it would be necessary to know the purpose of the training. The success or failure of the training could then be measured against this purpose. Here, if the purpose had been to alter the heterophoria, one could say that the visual training failed. On the other hand, if the purpose was to stabilize the heterophoria, the success of the training was beyond question. Unfortunately this judgment cannot

be made here since, in most instances, the training these 17 subjects received did not involve their heterophoria one way or another.

Another source of data used was that of the private practice of the author. This practice was started by the author's father in 1919, consequently data from repeated measurements might be available for periods up to 35 years. During this 35-year period the data could have been taken by as many as 6 different examiners although this situation would be rare. Generally speaking, the patient would have been seen by no more than three different examiners.

The middle file drawer was chosen and the records from this file searched to find those who had been seen at least 5 times. This file held the records of patients whose last name began with the letter P. In this particular file were the records of 20 patients who had been seen at least 5 times: 7 out of these 20 had been seen 7 or more times. The raw data for these 7 patients are given in Table V. The first column identifies the subject by first and second initial, the second the patient's age at the initial visit. The year of the visit is given by the first figure. The calculation results are shown in Table III.

The standard deviation, the variances, and the coefficient of consistency for the 20 subjects seen 5 times were calculated and are also shown in Table III.

In addition the records were searched for patients who had difficulty with their convergence function and for whom base-in prism had been prescribed. 6 patients were discovered who had been seen 5 times. The result of the calculations for these patients is shown in Table III.

Flom[5] has reported data which can be given the same statistical treatment. His data are for 15 subjects seen 4 times. The results are shown in Table III.

Except for the subjects given prism prescriptions, the data reported here indicate that the distance heterophoria measurement from a wide range of subjects by many different examiners has a standard error of measurement of from 0.5Δ to 0.8Δ. Thus a single determination of the distance heterophoria may be in error by 1.0Δ to 1.6Δ.

Tests for distance heterophoria have a high to moderately high index of consistency even when the time period between the first and last measurement is many years. The data indicate that there is not much, if any, change in the distance heterophoria with time.

The data can be interpreted from a negative point of view also. Before one can be reasonably sure that a change has occurred in the distance heterophoria one must have a change between two successive measurements which is greater than 1.6△.

TABLE V.

Subject	Age at first visit	Visit 1	2	3	4	5	6	7
AA	14	42/—4	43/—4	44/—3	46/—5	46/—5	48/—6	49/—5
HA	41	43/—4	44/—2	46/—2	47/—5	48/—4	49/—4	51/—4
NC	13	30/—2	33/—2	35/—2	40/—2	47/0	50/+1	52/0
HH	24	43/+4	45/+1	48/+2	48/+3	50/+3	52/+6	54/+3
SL	35	37/0	38/0	45/0	46/0	47/0	48/0	49/0
EP	48	38/+5	41/+4	43/+4	45/+3	48/+8	51/+8	53/+3
GP	35	38/0	41/+2	44/—1	47/+1	48/—1	51/0	52/—1

Legend: Data of 7 private patients seen at least 7 times. The first number under each visit represents the year of the visit. The second number gives the distance heterophoria found at that visit.

It is interesting to note that the statistical data confirms the impression gained on one refraction as to the instability of the convergence function. The coefficient of consistency is low and the standard error high for the distance heterophoria in a group of subjects diagnosed as having convergence instability. It should be pointed out that these patients received base-in prisms as a therapeutic measure. Perhaps the prisms induced the instability.

Before concluding this paper, it should be emphasized that the whole discussion has revolved solely around the point of view of reliability. Reliability of measurement is entirely independent of validity of measurement. In reliability no question is raised as to just what function a particular test measures or whether the test is a good or a bad measure of the function. The problem is whether the test measures the same thing all the time. In other words, are the results of a particular test similar if the test is repeated? The results of this paper indicate that as far as the distance heterophoria measurement is concerned this question can be given an affirmative answer.

Whether a test measures what it is supposed to measure, is a question of the validity of the test. It is at this point that the various hypotheses concerning visual functions must be applied. Most people generally assume that tests are designed to test various theories. This is of course true at times but usually the theories grow out of the results of tests, particularly in the clinical sciences such as optometry. Heterophoria measurements represent a good example of this growth of theory. These measurements have been regularly made with little change in the method of administering the test for nearly 90 years. During this time the meaning of the results has been changing. Obviously, the validity of the test depends on whether the theory of

interpretation is correct. Fortunately the reliability of the test can be considered independently of the theoretical interpretation.

It should be clear that the method of Brozek and Simonson can be applied to all the various measurements used in refraction and that distance heterophoria was chosen merely as an illustrative example of the method.

SUMMARY

1. The method of Brozek and Simonson is applied to heterophoria determinations.

2. The error of measurement of distance heterophoria approximates 1.5△.

3. The consistency of the heterophoria measurement is moderately high to high.

4. The standard deviation of the distance heterophoria measurement on several groups of subjects ranges from ±1.1△ to ±2.8△ with the mean standard deviation being about ±1.5△ and consequently the variance will be about 2.3△.

REFERENCES

1. Manas, L. and Shulman, P., The variation in the accommodative-convergence accommodation ratio upon periodic retesting, Am. J. Optom. and Arch. Am. Acad. Optom., 31:385, 1954, Table IV.
2. Scobee, R. and Green, E., Tests for heterophoria, Am. J. Ophth., 30:436, 1937.
3. Ibid, p. 439.
4. Brozek, J., Simonson, E., et al., Effects of practice and the consistency of repeated measurements of accommodation and vergence, Am. J. Ophth., 31:191, 1948.
5. Flom, M., to be published.

ANNOUNCEMENT

PLASTIC WASHABLE NEARPOINT TEST CARD

A new plastic washable nearpoint card has been developed by the Pennsylvania Optometric Association. The card of 7½ inches by 5 inches is designed so that it may be cut into two separate cards. On one side will be found figures, illiterate E's, and reading material in various small type. On the other side appears a grid in circles, one with vertical lines and one with horizontal lines. The cards have been used in clinical practice with good reports. The cost of the card is $1.50. Checks should be sent to the Pennsylvania Optometric Association, 1312 Seventh Ave., Beaver Falls, Pennsylvania.

MYOPES VERSUS NONMYOPES — A COMPARISON*

Francis A. Young†
Department of Psychology, State College of Washington
Pullman, Washington

On the basis of information gathered during the course of a vision survey made in Pullman, Washington, it is possible to draw comparisons of an intellectual, physical and environmental nature between myopes and nonmyopes. The unusual economic equality of Pullman and the surrounding Whitman county eliminates the possibility of any differences being due to deprivation or greatly different living conditions, and restricts these differences to actual differences in heredity and constitution and in behavior.

To dispel any fears that the farmers' children may be ruining their eyes poring over Sears & Roebuck's catalog by the light of a kerosene lamp, thereby weakening any conclusions concerning the relationship between myopia and amount of reading, the following description from U. S. census data is presented.[13, 14]

> Whitman county, located in the southeastern corner of the state of Washington, has a total area of 2,167 square miles, or 1,386,880 acres. Of this land area, 97 per cent is divided into 1,800 commercial farms, with an average size of 750 acres. In addition to the commercial farms there are 214 farms averaging 42 acres each which are not classified in the 1950 census as commercial farms. These noncommercial farms will not be considered further since they are scarce in the area immediately surrounding the city of Pullman. The average value of the commercial farms in Whitman county is $94,465 and 82 per cent of these farms sell products valued in excess of $5,000 per year, with 61 per cent grossing more than $10,000 per year. In 1949 the total value of all crops sold amounted to 31⅓ million dollars, which leaves a net average income after deducting operating expenses but not taxes, of $12,250.
>
> On the basis of a net farm income in excess of $12,000 per year one might think that Whitman county is an unusual county. It is. For more than thirty years it has been the leading producer of winter wheat and in 1950 produced 1.25 per cent of all the wheat produced in the United States. With average yields in excess of 27 bushels per acre it is also the richest wheat country in the world. With a Farm Operator-family-living index of 208, Whitman county ranks 13th of the 3070 counties in the United States. This index which is based on per cent of telephone, electric light and automobiles, together with value of farm products, is considered by the census bureau to be closely related to the actual standard of living.

In terms of selected indicators used by the census bureau a more direct comparison may be made between the urban population of Pullman and the rural nonfarm and rural farm population. The data for this comparison is presented in Table I.

From Table I, it is apparent that the major difference between the

*Read before the annual meeting of the American Academy of Optometry, Toronto, Ontario, Canada, December 12, 1954. For publication in the April, 1955, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Ph.D. Member of faculty. Fellow, American Academy of Optometry.

TABLE 1

A comparison between Pullman urban population and Whitman county rural nonfarm and rural farm population in terms of per cent ownership of comparative items. Compiled from 1950 U. S. Census data.

Comparative Items	Pullman – urban	Whitman County	
		Rural nonfarm	Rural farm
Hot water and baths	83.7	71.8	75.9
Mech. refrigerators	83.2	84.3	93.4
Radios	98.9	96.5	98.7
Kitchen sinks	98.5	95.2	98.9
Electric lights	99.8	98.3	95.0
Hot and cold running water	83.7	83.7	84.4
Central heating	53.8	22.5	25.9
Mech. washing mach.	*	*	92.0
Home freezers	*	*	41.0
Television**			

*No comparable data.
**Not available in Whitman county at the time of the census.

urban and rural housing characteristics lies in the use of central heating. This is understandable in terms of construction dates, since forty per cent of the urban homes were constructed since 1940, while seventy-five per cent of the rural homes were built before 1919. More than 95 per cent of all groups had electric lights, radios and kitchen sinks. More than 83 per cent of all groups had hot and cold running water and electric refrigerators. The farm group, with 76 per cent and the rural nonfarm group, with 72 per cent having hot and cold running water and complete baths, fall slightly below the corresponding figure of 84 per cent for the urban group. There is no comparable data for the urban and nonfarm groups, but 92 per cent of the farm group had electric washing machines and 41 per cent had food freezers. Television was not available in Whitman county at the time the census survey was made.

The median income of all Whitman county with its 15,000 urban, 9,000 rural nonfarm and 8,500 farm population is $3,703, while the mean income of Pullman and its immediate environs is $8,400. The median income of the survey sample is approximately $5,000 with no families falling below $3,000. With this relatively high level of income for all participants there is no reason to believe that the basic living conditions are greatly different for any part of the sample. This conclusion is further supported by the results obtained on the questionnaire concerning the diet of all the children surveyed.

The study of the diet of the children surveyed had a double motive: primarily for the relationship between diet and myopia and, secondarily, to further evaluate the economic status of the sample.

Nutritional deficiencies are an often cited cause of myopia, with

much of the emphasis being placed on insufficient calcium[2, 4, 5, 7, 8, 9, 11] Some authors feel that the myopic individual is simply not eating foods which provide essential nutrients or, at least, is not eating enough of such foods. On the other hand, other writers restrict the malnutrition to the eye itself. Thus an individual may be getting an ample and balanced diet but still not be utilizing the food properly as far as the eye itself is concerned. Of these two general theories of the relationship between ametropia and diet, only the first lends itself to any type of test at the present time and even this test must be rather gross. The present state of blood chemistry does not permit us to evaluate the second hypothesis.

A test of the relationship between diet and myopia ideally requires complete control over the food intake of the individual with accurate records of the type and amount of food eaten, such as may be achieved in the animal laboratory. An institutional situation in which groups of neonates are placed on various diets until full growth is reached would constitute the human equivalent of the animal laboratory.

In 1940, Miller[11] attempted to get at the answer to the question of diet and myopia by asking a group of ametropes the following questions:

(1) During the growing years what kind of a diet did you prefer?
(2) Were you a hearty eater as a child, especially of meat?
(3) In eating meat did you carefully pick out the muscular fibers and discard all connective tissue and fat?
(4) Were you in the habit of cutting off a bite of meat and eating it, if it contained all of the tissues and fat?
(5) Did your habits of eating continue through your entire growing period of years?

As might be anticipated, most of the subjects ate a balanced diet — 83 per cent of the hyperopes and 80 per cent of the myopes. Half of the subjects were hearty eaters of meat. The myopic subjects were more apt to discard the connective tissue and fat, 85 per cent to 45 per cent, and were less in the habit of eating a bite of meat without alteration, 26 per cent to 58 per cent. Of the hyperopes 96 per cent maintained their eating habits throughout the growth period, whereas only 84 per cent of the myopes did the same. Miller places great stress upon the differences in eating habits with respect to fat intake. Since fat may be obtained in many ways other than meat it is doubtful whether this stress is justified.

The basic nutritive elements have been determined and the quantities required by the sexes at different age levels and for different degrees of activity have largely been calculated. The latter are usually given in terms of the amounts required to meet these basic minimums for the average person. Whether the stated amounts in terms of weight

or volume actually will provide the necessary minimum amount for an individual depends in part on the digestive system of the individual and its ability to turn food into nutritive elements.

According to Gillett,[1] six basic groups of foods are needed in proper amounts to supply basic requirements. The groups are: I, milk and cheese; II, fruits and vegetables; III, eggs; IV, meat, fish, poultry and legumes; V, bread, cereal and other grain products; and VI, fats and sweets.

In the Pullman study the parents were asked to check the number of times each week the child ate types of foods listed in Gillett's six groups. No attempt was made to have the parents record the amount of food the child ate. Such a request is not easily complied with, even in the laboratory situation, and is virtually impossible of fulfillment in the home with several children. The present approach indicates whether the food elements are available at all and indicates roughly what quantity is being consumed; this is especially true with respect to milk and eggs. This specific approach allows a judgment as to whether or not the diet is balanced without consulting the parents. In addition, it permits the comparison of myopes and nonmyopes in terms of specific foods, thus indicating whether there are differences between the two groups with respect to such foods as milk and fats, insufficient quantities of both, having been given as causes of myopia.

The data on diet has been handled for the boys and girls separately since there are sex differences in need and preferences. Further, the data were analyzed in terms of myopes against nonmyopes when the dividing line is emmetropia, and again with those with myopia in excess of one diopter being compared with the children who have hypermetropia in excess of one diopter. All retinoscopic findings are in terms of equivalent spheres and pertain to the right eye only. No separation was made on the basis of age since all the age groups need the same types of food and are likely to differ only in the quantity required.

In the comparison between 100 male myopes and 230 male nonmyopes we find that the myopes eat cake a significantly greater number of times per week than the nonmyopes in terms of the "t" test. This is the only significant difference with respect to foods between the two groups. The myopes also sleep a significantly fewer number of hours per night than the nonmyopes. When the one diopter or more myopic males are compared with the corresponding group of hyperopes, the groups containing 37 and 49 boys respectively, the myopes eat significantly fewer eggs and cookies, but more fresh meats other than beef and pork.

In making the same comparisons for the girls the following differences are all significant at the five per cent level or higher: the 106 female myopes eat more butter and oleo and bread, and fewer eggs than the 197 nonmyopes: there are 39 myopes of one diopter or higher who eat potatoes less often than the 55 hyperopes.

In summarizing these results it is apparent that there are no consistent differences in the number of times per week that the myopes and nonmyopes eat particular foods. Both groups eat a fairly well balanced diet. The lack of differences and the balanced diet of both groups indicates that there is no close relationship between diet and myopia, at least as far as diet can be determined in terms of the number of times per week the subjects eat various foods.

The equality of diet and general living conditions is of considerable importance in the evaluation of physical differences between the myopes and nonmyopes. Height and weight are related to type and quantity of diet which in turn is related to socio-economic level. If these two factors may be equated for the two groups, then any physical differences must be due to some cause or causes other than diet and economic level. The assumption of equality is made here in the light of the evidence which has been presented. Inasmuch as myopia is also related to socio-economic level in the same manner that diet and height and weight are, it is easy to fall into the error that one is the cause of the other. There are a number of differences other than these between socio-economic levels, such as: amount of near work, conditions of near work, type of recreation, values sought, etc., any or all of which may be said to be related to myopia in the same way that some have said that diet is related. The only way that any of these variables may be tested as to their relationship with myopia is to make all other factors equal and see if different degrees of diet, for example, are associated with different degrees of myopia. There is a negative way in which the presence or absence of a relationship may be determined. If diet is the same for a number of subjects and these subjects are found to have different degrees of ametropia, then diet is not causally related to degrees of ametropia. Or, stated in another way, and the way used here, if groups with different degrees of ametropia are found to have the same diet, then there can be no relationship between diet and ametropia.

Applying the same type of logic to the evaluation of the relationship between myopia and physical characteristics, the conclusion follows, that if subjects with different degrees of ametropia show no differences in physical characteristics, then these physical characteristics are not causally related to ametropia. Unless two variables or sets of measure-

ments vary concomitantly in either the same or opposite directions, they cannot be causally related in any way either directly or indirectly.

If no differences between height and weight are found, several other conclusions follow. Since height and weight are dependent primarily on three variables, diet, hereditary characteristics and constitutional state, one of which, diet, may be eliminated as a variable in this case, and a second, constitutional state, may be considered restricted to a very narrow range of variability for the Pullman children, a lack of physical differences would indicate that there are no significant differences in the hereditary characteristics of the myopes and nonmyopes with respect to height and weight. One may conclude, therefore, that ametropia is transmitted independently of height and weight, but not that there are no hereditary differences between myopes and nonmyopes with respect to ametropia, since no test of this hypothesis has been made.

The study of physical characteristics of Pullman school children was undertaken to test several hypotheses which had been suggested on the basis of primarily clinical evidence. One hypothesis, presented by Johansen,[3] stated that myopes are taller than nonmyopes. Johansen considered his results as support for the Biologic Variation Theory of myopia development. The fallacy of this line of reasoning has been discussed above and elsewhere.[15] Johansen used school records to locate students with low acuity and submitted these students to a complete visual examination. He computed the mean height and weight of myopic and nonmyopic boys, 12, 13, 14, and 15 years old by age groups and tested the differences between the means. On the basis of a significant difference in the 15-year group between the heights of 15 myopes and 80 nonmyopes in favor of the myopes, he concludes that myopia is strictly an hereditary phenomenon. There was no evaluation of any of the other variables known to be related to height and weight. Without such an evaluation his conclusion is meaningless. A test was also made of a second hypothesis, suggested in one of Koch's[9] discussions, that myopes have broader faces than nonmyopes, and in terms of this, wider set eyes. This results in excessive convergence effort which leads to the development of myopia.

Height to one-quarter of an inch with low heel shoes on and weight to one-quarter of a pound with normal indoor clothing were taken on a standard Fairbanks school scale with a height rod. The sample was divided into sexes and years, and into those with minus refraction and plus refraction. The minus and plus refraction groups were compared by means of the "t" test within each sex and age group. No significant differences were found between any of the groups in

terms of either height or weight. Our results did not support those of Johansen in any way.

To determine whether there were any peculiarities in the Pullman sample it was compared with the physical measurements made by the Brush Foundation.[13] The comparison indicated that from years five through thirteen, both the boys and the girls in the Pullman study parallel those in the Brush study in Cleveland, except that both sexes in the Pullman group are approximately an inch and a half taller and four pounds heavier than the Brush group. From fourteen through seventeen the boys are still an inch and a half taller but average seventeen pounds heavier, while in the same age range the girls are about the same as those in the Brush group.

In testing the hypothesis concerning the relationship between myopia and broadness of face, a comparison was made between the interpupillary distance at far point and the zygomatic arch measurements of the myopes and nonmyopes. Testing these differences by ages and sexes with the "t" test revealed no significant differences between interpupillary distances or the zygomatic arch, the width of the face at the cheek bones. There is a relationship between the interpupillary distance at far point and the arch measurement of +0.76 for all the subjects combined. This very high correlation for physical measurements is the result of the extreme variation between subjects ranging from five years to seventeen years. When the two measures are correlated within sexes and age levels the average correlation is approximately +0.57, which is much closer to the usually found correlation between physical measurements.

In addition to these comparisons between myopes and nonmyopes, the relationship between intelligence as measured by the Stanford Binet intelligence test and static refractive error was invevstigated. Here again a confusing situation presents itself. IQ scores correlate with socio-economic status[10] in the same manner that the prevalence of myopia does, high status groups have higher IQ's and a higher proportion of myopia, and vice versa. Why should high socio-economic groups have higher IQ's? This question is unanswerable at the present stage of our knowledge concerning intelligence. Unfortunately, intelligence tests do not measure intelligence directly. A test score is the result of at least three variables, innate intellectual ability, environmental conditions and motivation both when taking the test and in exposure to past environment. This means that differences in test scores are dependent primarily upon differences in intellectual ability only when the environment and motivation for our subjects are the same. In comparing different socio-economic groups all of these variables are

likely to differ with respect to the groups. It is quite probable that different socio-economic groups arose in the first place because of differences in intellectual ability and motivation and partly as a result of environment. But once established, these groups set up environments and motivations which operate toward preservation of the group. If the concept of heredity is accepted, these more intelligent parents in the higher level groups should pass on a higher intellectual ability to their progeny, but they also set up a better environment and create an anxiety level in their offspring, so that while their children have higher IQ's on the average than children in lower groups, it is impossible to say why they have higher IQ's, since all factors which make for high IQ's are present. To some extent the same relationship holds for myopia.

Binet IQ scores tend to be relatively stable with respect to age. Thus a child may be tested at age five and found to have an IQ of 100. Upon later testing at age 17 the subject will still have an IQ close to 100 in most cases. The reason for constancy of the IQ lies in the nature of the test construction and standardization. The lack of constancy which occurs is related to the individual environment, motivation and intellectual ability. In an environment as stable as that described for the community of Pullman, with as a high a proportion of high socio-economic level families, the assumption of constancy of IQ is likely to be correct. The making of this assumption permits correlation between refractive error and IQ scores for different socio-economic groups but without separation into age groups even though refractive error varies with age. If both refractive error and IQ scores changed systematically with age, this type of approach would lead to a spuriously high relationship between IQ and refractive error unless a partial correlation technique were used. An alternative approach under such circumstances would be to correlate the two measures within socio-economic groups by ages and use a median or mean correlation coefficient as the measure of the relationship.

The correlation coefficients between IQ and refractive error within the seven occupational groups used in the Pullman study, range from —.22 to +.16, but when evaluated in terms of the size of the group, none of the correlations are significantly different from zero. To complete the analysis of these data the subjects in each group were divided into sex groups and the correlation determined by sex within each occupational group. Again there was no significant correlation. As a check of the relationship between IQ and refractive error with respect to age, the two measures were correlated for males and females separately and combined for each age level. Since no significant correlations were

found within the age groups, the original assumption concerning the constancy of the IQ is valid for this sample. The groups classified on the basis of parent's occupation ranged in size from 21 children in the unskilled group to 250 in the professional class, with a total N of 444. All Binet tests were given by qualified psychometrists within three years of the visual survey. The average IQ of the children in the occupational groups ranged from 107 in the unskilled group to 121 in the professional group, with the other groups falling between 109 and 116. Since the professional group comprises over half of the subjects the average IQ is 117, which is considerably above what was intended to be the national average of 100. This high average IQ serves to point out the relatively unusual population in Pullman and, also, to credit a progressive and outstanding public school system.

The no-relationship conclusion follows again with respect to the relationship between IQ and refractive error.

The myopes and nonmyopes were also compared in terms of the number of hours per week spent in close work, which was defined for the purposes of the survey, as work done within twenty inches of the eyes and included separate requests for time spent in reading, housework, sewing, hobbies, recreation and other work. The comparison discussed here, however, is restricted to the amount of reading—in the school situation, outside the school situation, and combined. The question concerning the number of hours spent in reading was repeated in three different ways, requiring various degrees of specificity in the answer. Three measures of total time spent in reading were provided. Two of these were correlated to provide a measure of the reliability of the answers to this question; the third measure has not been analyzed. The reliability of this question is 0.82.

The supposed relationship between near work and myopia has been discussed in detail so often that no discussion of it will be included here other than to suggest that all the restrictions which apply to the test of the relationship between intelligence and refractive error also apply here with equal force. As is well known, the amount of reading which a child does increases as he progresses through school, and, at the same time, the proportion of students having myopia increases in the same manner. By dint of uncritical thinking, these two occurrences are related causally in much the same manner as cigarette smoking and lung cancer have been related. As has been pointed out earlier, many other variables are related to age in the same way that reading and minus refractive error are related. Those supporting the reading-myopia relationship choose to ignore these other variables in favor of this one which fits into their preconceived ideas as to the cause of myopia.

The weakest part of any test of this relationship is the measure of the amount of near work. Since all children in each grade are required to do a certain minimum amount of reading, although it is probably certain that not all children do even the minimum amount, the extracurricular reading becomes the most important variable in determining the amount of reading. Unfortunately, it is also the most difficult to determine with any degree of accuracy and confidence. The method used to determine the amount of out-of-school reading has already been described. The amount of reading done in each grade was obtained from the school superintendent, principals and teachers. If all age groups corresponded with grade groups exactly, one would expect no correlation between refractive error and amount of reading done in school when the correlations were within age groups. However, since age groups do not completely correspond with grade groups, correlations of both positive and negative sign but of small magnitude are found. To take advantage of these correlations the school reading and extracurricular reading were combined to form a total reading score.

The relationship between the amount of reading and refractive error has been determined by the use of partial correlation over the entire group of subjects and by simple correlation within age groups. In order to factor out the relationship of each measure with age it is necessary to determine the correlation between the measures and age. The correlation between refractive error and age for 393 subjects is —0.28. The relationship is negative since mean refractive error moves toward minus with increasing age. The correlation between total reading time and age is +0.25; between refractive error and total reading time —0.34. While the value —0.34 is reduced to —0.29 when age is partialled out, it is still significantly different from zero at the 0.1% level. This correlation coefficient although low supports the conclusion that minus refraction is associated with increased time spent in reading.

The correlational analysis by age groups for both extracurricular and total reading time is presented in Table 2.

The amount of time spent in reading in school increases from approximately seven hours per week in the second grade to 11 hours in the third grade and 14 in the fourth through the eighth grades. It jumps to approximately 21 per week in the ninth grade and reaches 23 hours in the twelfth grade. In contrast to this stepwise progression the average number of extracurricular reading hours rises steadily from five hours per week at six years to 12.5 hours at 12 years of age. From 13 through 17 years of age it averages 10.5 hours per week.

TABLE 2.
The age-group correlations between refractive error and extracurricular time and total reading time.

Ages	Number	Extracurricular reading time	Total reading time
6	29	0.29	0.25
7	43	0.09	0.08
8	71	0.02	—0.06
9	60	—0.03	—0.15
10	51	—0.06	—0.04
11	37	0.03	—0.11
12	28	—0.45	—0.45
13	24	—0.47	—0.47
14	19	—0.32	—0.28
15	28	—0.17	—0.21
16	20	—0.34	—0.35
17	15	—0.53	—0.53

If the incidence of myopia is related to the number of hours of reading, one might expect little or no correlation between refractive error and reading before the third or fourth grade when the child is eight or nine years old, a regular increase in magnitude of a negative relationship between error and reading with a leveling off at the sixth or seventh grade, 12 to 14 years of age, and a slower or no increase in the magnitude of the correlation coefficient after 14. This general pattern is supported by the correlations between refractive error and hours of reading, both extracurricular and total, with small positive correlations at ages six and seven and a shift to small negative correlations between ages eight and eleven. At ages 12 and 13 significant correlations of —0.45 and —0.47 are found. From ages 14 through 17 the correlations are all negative and in order are —0.28, —0.21, —0.35, and —0.53. With only two exceptions these values are the same within a maximum difference of 0.04 for both reading measures. Because of the small groups involved only the correlations at 12, 13 and 17 years of age are significant at the 5% level.

Taken together the partialled total group correlation and the correlation within age groups indicate that there is a significant though small relationship between refractive error and hours of reading. These results were obtained on small groups using a cross sectional approach. The use of small sample statistics insures that the relationships found here would still be found in a similar study using larger groups, although it is not possible to predict what the magnitude of the relationship would be under those circumstances. It is possible to say that the relationships found here would be considerably higher if a longitudinal study could have been made. The magnitude of the relationship indi-

cates that reading is related to the incidence of myopia, but any attempt to describe the nature of the relationship in terms of its method of operation or the relative importance of this factor in comparison with other factors such as heredity falls in the realm of conjecture.

Of the comparisons made between myopes and nonmyopes only amount of reading is related significantly to refractive error. The other variables investigated, diet, height, weight, interpupillary distance, face breadth, and intelligence, were found to be unrelated to refractive error. Since the relationship between reading and refractive error is too small to account for the present incidence of myopia, other factors and especially heredity and its relationship to near-work must be investigated before the final answers are obtained.

REFERENCES

1. Gillett, Lucy H. *Nutrition in Public Health*. Philadelphia: W. B. Saunders Co., 1946.
2. Henderson, T. The Constitutional Factor in Myopia. Tr. Ophthal. Soc. U. Kingdom, 1934, 54, 451-459.
3. Johansen, E. V. Simple Myopia in Schoolboys in Relation to Body Weight and Height. Optical. Develop., 1951, 21, No. 7.
4. Johnson, C., Saunders, M., and Mull, H. K. The Effect of a Carrot Diet on Near-sightedness. Amer. J. Psychol., 1944, 57, 84-86.
5. Knapp, A. A. Vitamin D Complex in Progressive Myopia. Amer. J. Ophthal., 1939, 22, 1329-1337.
6. Koch, C. C. Possible Characteristics of Myopia. Amer. J. Optom., 1932, 9, 112.
7. Laval, J. Vitamin D and Myopia. Arch. Ophthal., Chicago, 1938, 19, 47-54.
8. Laval, J. The Relationship Between Myopia and Avitaminosis. Amer. J. Ophthal., 1941, 24, 408-412.
9. Law, F. W. Calcium and Parathyroid Therapy in Progressive Myopia. Tr. Ophthal. Soc. U. Kingdom, 1934, 54, 281-290.
10. Loevinger, Jane. Intelligence as Related to Socio-economic Factors. In G. M. Whipple (Ed.), *The Thirty-ninth Yearbook of the National Society for the Study of Education*. Part I. Bloomington, Ill., Public School Publishing Co., 1940.
11. Miller, H. Is Myopia a Deficiency Disease? Amer. J. Ophthal., 1940, 23, 296-305.
12. Simmons, Katherine. The Brush Foundation Study of Child Growth and Development. Monog. Soc. Res. Child Devel., 1944, 9, No. 1 (Serial No. 37).
13. U. S. Bureau of the Census. *County and City Data Book*, 1952 (a statistical abstract supplement). Wash., D. C., U. S. Gov. Print. Off., 1953.
14. U. S. Bureau of the Census. *U. S. Census of Agriculture*, 1950. Vol. I. Counties and State Economic Areas, part 32. Wash., D. C., U. S. Gov. Print. Off., 1952.
15. Young, F. A. An evaluation of the biological and nearwork concepts of myopia development. Paper read at the Amer. Acad. of Optom., Chicago, Dec., 1953.

PROGRESS REPORT OF PARTIALLY BLIND CASES*

I. Irving Vics†
Albany, New York

About 25 years ago Feinbloom[1] proposed that the correct approach to subnormal vision was visual rehabilitation. In 1933, he suggested a method for treating the partially blind, basing it on the psychological problems which these patients had. The training procedures instituted in this process of reeducation, permitted him to report that 60 per cent of a group of 500 unselected patients were rehabilitated to useful vision. Since 1933, additional papers[6, 7, 8, 9] have been submitted by optometrists who have used the Feinbloom technique and who further illustrated the effectiveness of his approach and the value of his contribution. It is interesting, therefore, that so many optometrists, who do but little work with the partially blind, still ask the question so often posed by the patients themselves: "Will vision get worse or will it improve with the wearing of telescopic spectacles?"

A review of the literature written since 1933, shows that most writers concerned themselves with the initial examination period and the rehabilitation effected through the use of telescopic spectacles, but few reported the progress after the patients received and used their devices. This report will attempt to formulate a response to the above question by presenting four case reports of patients who have used telescopic spectacles for more than one year, and a statistical analysis of 100 patients who have used telescopic spectacles between periods of less than one year up to more than eight years.

CASE REPORTS

As it sometimes happens in the practice of those who work with the partially blind, one case becomes outstanding in showing marked improvement. Such a patient, in the writer's practice, was Mr. E.W.

In 1930, this patient sustained a right temporo-parietal fracture of the skull, followed by convulsions, due to an automobile accident. For six hours, he was unconscious, and after wandering around the mountains and bus and railway stations for 72 hours, was finally admitted to a hospital. X-rays showed a linear fracture right temporo-parietal skull, horizontally, four inches, and cerebral hemorrhages.

*Read before the annual meeting of the American Academy of Optometry, Toronto, Ontario, Canada, December 14, 1954. For publication in the April, 1955, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
†Optometrist, Fellow, American Academy of Optometry.

At the time of hospitalization the patient was delirious and irrational. Surgery was not performed.

A study of the eye grounds by an ophthalmologist revealed small punctate choroiditis. The fields of vision showed an homonymous hemianopsia, while study by aurists revealed two dead labyrinths without loss of hearing. Ophthalmological and aural findings here indicated central nervous destruction. Vision, balance and speech were all impaired, and the patient also showed anomic motor aphasia. Re-education was begun, but by 1932, he had shown no marked improvement.

The ophthalmological examinations at this time again revealed an homonymous hemianopsia and the diagnosis of cerebral lesions accounting for defects of speech, writing, vision, and equilibrium was made. His corrected vision was recorded as O.D. 20/100. O.S. 20/70.

By 1935 the patient had improved enough to be employed as an orderly in the radiological department of a hospital. Because of the destruction of labyrinthine tracts in the central nervous system, the patient staggered and could not walk in the dark. He was jeered at, which humiliated and depressed him, often causing him to become mute and his speech unintelligible. The ophthalmologist's report at this time showed his corrected vision to be O.D. 10/100. O.S. 10/60. The size and shape of the blind spots were normal and the peripheral fields showed some contraction, particularly temporally. There was an indefinite scotoma in the right eye. The diagnosis of papilloedoema was made.

By 1936 he was able to study more difficult subjects and in 1938, was appointed chief radiological technician at the hospital. In 1943, he sustained an exposure of 4500R to his right forearm and amputation of the arm followed.

He was first seen by the writer in October, 1947. His corrected visual acuity was O.D. 12/350. O.S. 12/175 with the following correction. O.D. +1.50 D. sph. $\bar{c}$ +1.00 D. cyl. axis 105. O.S. +1.25 D. sph. $\bar{c}$ +1.50 D. cyl. axis 90. His age was 40.

The subjective test with the addition of a telescopic spectacle brought his vision to O.D. 12/97. O.S. 12/52. At the near point a +8.00 addition permitted him to read the finest Jaeger print. He was then seen for several rehabilitative visits and trained in the use of telescopic spectacles. He made rapid progress and only four sessions were required to effect the relearning process. He began, as do most other patients with subnormal vision, by reading from primers through the grades and ending with newspapers. At the conclusion of this part of the training, he expressed a desire to be able to do drafting,

as the hospital trustees contemplated the building of a new wing to which the X-ray department would be moved and he wished to submit his drawings of a suggested new arrangement of rooms. Some time was then spent in teaching him to use the telescopic spectacles for drafting purposes. He received his lenses in November, 1947, and returned for a progress examination December, 1947, at which time his acuity with the telescopes was recorded at 12/44 and at near the patient could read the finest Jaeger with ease. He was next seen in March, 1950, at which time he stated that he felt his uncorrected visual acuity at distance had improved. He was still using the telescopic spectacles which proved satisfactory. His health had been good during the past three years, and his work at the hospital was progressing smoothly. His distance visual acuity with his regular spectacles was now recorded as O.D. 12/155. O.S. 12/97. He was again examined and the following correction was prescribed. O.D. —0.50 D. sph. $\frown$ +2.00 D. cyl. axis 105. O.S. —0.25 D. sph. $\frown$ +2.00 D. cyl. axis 90. Add. O.U. +3.00 D. sph. The patient's visual acuity with this correction was O.D. 12/87. O.S. 12/32. At the near-point the patient was just able to read the finest Jaeger lines of type. He returned for a progress check in May, 1950, and his vision with his spectacles was now recorded as 12/32 O.U. In April, 1951, he was again examined, the prescription changed and the new visual acuity was now recorded as O.D. 12/25. O.S. 12/20, with regular spectacles. The patient was now using his telescopic spectacles on occasion when he needed critical vision, since these now afforded 12/12 acuity. Two years later, in April, 1953, he complained of asthenopia due, he believed, to much reading. He was now 46. His general health was good. The visual acuity of O.D. was 12/32 and O.S. was 12/25 which was improved to 12/20 and 12/15 with a change in lenses. At near with a +2.75 D. add he could read the finest Jaeger with ease. Trifocals were prescribed for constant use. In June, 1954, he was reexamined, showing no change in refraction, but desired a duplicate correction in an absorptive tint for use while driving his car. He had discontinued the use of his telescopic spectacles about a year ago.

The analysis of a group of cases which follow later in this paper, indicate that 40 per cent of the patients make some improvement, 39 per cent remain at the same level that was attained after the rehabilitative period, and 21 per cent drop below the level achieved at the progress check. The next three reports are typical of these three categories.

The first is that of a young girl, age 14, who made progress and showed an improvement in her visual acuity one year after she had received her telescopic spectacles. Miss M.F. when first seen in July,

1953, was morose, uncertain, and silent until she was told that she could now enter a public school after having spent seven years in a school for the blind. She had congenital cataracts and her lenses had been needled nine times. Her mother stated that prior to the first surgical intervention, the child could not distinguish light from dark. She had not been doing so well in Braille for the past year because she discovered that she was able to read large printed letters and the school would not permit her to read print. Her visual acuity with her correction lenses was O.D. 12/122. O.S. 12/122. This was improved to 12/86 in each eye with telescopic spectacles. At near with a +8.00 add, she could read the finest Jaeger print, letter by letter, reading the simpler words as a unit, a skill which she had learned herself.

Her training in rehabilitation was begun and the patient made progress through the primers and ending with newspaper print, all within six visits. During the session spent in writing, it was interesting to see her print her words and to read that she had written. "I am glad I don't have to go back to school this year." "I cannot do arithmetic in Braille." Her visual acuity at the end of the training period was O.D. 12/52. O.S. 12/68.

The patient had been in the 6th grade in the school for the blind and had she returned, would have had to repeat the year because of poor grades. At her new school, the principal took a personal interest in the child, and let her start in the 7th grade. At her progress check one month later, she told us she was doing very well in social studies and arithmetic, but was having difficulty with graphs. Her acuity with her telescopes was now O.D. 12/38 and O.S. 12/44. A year later, in August, 1954, the patient was found to be adjusted to her life among her seeing classmates. She had passed the grade with an 86.8% average and was to be advanced to the 8th grade. Her mother reported that her daughter was "reading and using the telescopic spectacles constantly the past year," and the patient added that the telescopes enabled her to read the finest print which her regular spectacles in bifocal form could not do. Her only difficulty was learning to write in script form. She claimed she was able to see the blackboard very well. Her vision with her telescopes was now recorded as O.D. 12/20, O.S. 12/25, and at near the patient was able to read the finest Jaeger type with ease with either eye. Subjectively, she now accepted a +6.00 add to read the finest print. This was given to her to replace the +8.00, and she was asked to return for further examination in one year.

The second category of patients whose vision remains the same after a period of years, is typified by the case of Mr. E.S., age 28. At his first examination in April, 1949, his history indicated that 10 years

before, his vision had started to blur and had remained about the same since that time. He could read large headlines, but hadn't been able to read fine print. The last specialist told him that his optic nerve was the cause of his difficulty, but could do nothing for him. His greatest desire was to be able to read. His visual acuity was O.D. 12/500, O.S. 4/500. The patient had primary optic atrophy. Subjectively, he accepted a —1.00 D. sphere in each eye with which he was able to read O.D. 12/175, O.S. 12/350. The addition of a telescopic unit improved the visual acuity of O.D. to 12/109. At near, with a +12 add, he could read F4 on the Feinbloom card. With an 8X M.S. he was able to read the finest Jaeger. Rehabilitation training was begun in April, 1949. It required 10 visits before he was able to read newspaper type. During these sessions, various lenses were tried. His new correction was made up as a pair of 2.2 telescopic spectacles with a +16.00 compound magnifier reading add. For constant wear, a pair of superarmorplate lenses —1.00 D. sph. O.U. in an A tint were supplied at his request to protect his eyes in his work as a warehouse loader.

The patient received these devices in June, 1949, and reported for a progress check in July, at which time he told of having been to the theater where he "saw excellently." His reading was "very good now" and he was "getting used to the glasses." At distance, the telescopes gave him the same acuity of 12/109 and at near with the compound magnifier add he read the finest Jaeger very well. He was next seen in March, 1953. His distance visual acuity was O.D. 12/350, O.S. 12/500. In October, 1954, he reported that he was still enjoying his telescopes, using them to advantage at baseball games, and at the movies, where he was able to sit in the rear of the theater. At near he could read any size of print. His distance acuity was the same, 12/109.

The patients who showed decreases in acuity after receiving their devices, form a heterogenous group since the vision losses are attributable to different causes. Here, one was chosen because of its varying degrees of complication.

Mrs. L.L., age 73, was first seen in March, 1946. She had glaucoma and iridectomies had been performed in both eyes in 1940. With her spectacles her visual acuity was O.S. 12/122, O.D. 4/500. Secondary traumatic cataracts were present. The discs showed glaucomatous cupping and the rest of the fundi had yellow exudates scattered peripherally. Adding telescopic units to each eye improved the acuity to O.D. 12/109, O.S. 12/52. A +10.00 add allowed her to read Jaeger 30. Rehabilitation was begun and progress was slow since she tired easily, which she attributed to her age. She expressed a desire to be able to see the hands on her watch and was content when she could tell time with the

telescopic spectacles. Towards the end of her training period, she was asked the usual question about avocation or hobbies, and she said that she would like to do crocheting if possible. Since she had progressed to reading newspapers she was invited to bring her needles and yarn. During the next two sessions, she readapted herself to the hobby she had not enjoyed for 10 years. She was given two pair of single vision spectacles for distance use, one made in infra-red absorptive green lenses. She was also given a pair of telescopic spectacles with a +6.00 add for reading and +3.00 for crocheting. At her progress check in September, 1946, her visual acuity was 12/32 with telescopes and with her regular spectacles 12/86. At near she could read the finest Jaeger.

She was again examined in June, 1947, and her vision was 12/97 with her regular spectacles. In May, 1948, her vision was lower. She felt that her intraocular pressure was up and this was the cause of the reduction. In June, 1949, her vision was 12/86 and at her request a bifocal correction was made for her. She was examined in 1950, 1951 and 1952 and again in May, 1954, at which time she felt that her vision had again become poorer. Her health had failed slightly. Her visual acuity was taken and found to be 12/97 with her telescopic spectacles. She could still crochet and had brought in a sample of fine stitching in various colors. She told of having "made quite a bit of money these past few years," creating full size tablecloths with this process. Since her ability to read had declined due to an increase in the density of the cataracts it was necessary to provide a pair of microscopic spectacles to again enable her to read the finest Jaeger.

Feinbloom[1] in his "Report of 500 cases of subnormal vision" in 1933, wrote that "Many of these patients are governed in their every attitude by the definite psychological fear of blindness. These are the cases which have been treated medically until the pathology has been arrested, yet they constantly worry over their imminent blindness. . . . It therefore becomes imperative in these cases, after demonstrating the possibility of visual improvement, to definitely assure them that the blindness is not imminent . . . asserting that by sufficient adherence on their part to the immediate work of adapting themselves to the device, their visual responses may improve — thus in place of this fear, we attempt to substitute a program of work destined to aid them."

Neill,[2] in his report on "The New Clear Image Lens" in 1953, wrote that "in some instances the improvement (visual acuity with telescopic spectacles) is startlingly greater than anticipated."

It would seem from the foregoing, that improvement in visual acuity for the partially blind is to some degree limited by the patient's own motivation, behavior and emotional pattern. Once the patient is

willing to accept rehabilitation, constant encouragement by the optometrist can produce beneficial changes in these patterns towards new goals in vision and total behavior.

ANALYSIS OF 100 CASES

The question of what progress had been achieved with a group of patients, whose entering vision classify them as partially blind, will now be reviewed.

Jaeckle,[3] in reporting on a difficult case of subnormal vision that was under his care from February, 1932, until October, 1933, whose entering vision was 1/200 and improved to 10/80 with telescopic spectacles, stated in his conclusion, "We do not look for much change in the actual distance acuity. The important thing is the patient's improved response to life about him."

With almost no exceptions, all optometrists in the field of subnormal vision have reported on the improvements of those rehabilitated to life about them. In the writer's practice the satisfaction of aiding those visually handicapped has been felt many times, but as important has been our observations of the changes in distance acuity.

The following is a report of 100 patients with subnormal vision taken from our private office files. These 100 patients were selected randomly from a group who, first, received telescopic spectacles; second, had returned for subsequent visits after having received their devices; third, had been examined within the past 10 years, and last had pathological conditions of a non-progressive nature. It should be stated that, as presented in a previous paper[4] all patients were able to read newspaper print with the devices given to them at the end of the rehabilitation period.

Table I shows the distribution of the major pathological conditions and follows rather closely Freeman's[5] distribution of pathology of an entering group of 175 cases. Freeman did not, however, indicate whether those who accepted aid showed a similar distribution. Should this be found to be the case, it might then suggest that those who desire to be helped, are not restricted to any particular pathology, but that the acceptance of rehabilitation follows this distribution of pathology with a like curve.

TABLE I. MAJOR PATHOLOGY

Retinal or Choroidal	45
Lens Involvement	24
Optic Nerve	14
Glaucoma	9
Cornea	3
Idiopathic	4
Physical Anomaly	1
Total	100

Years of Partial Blindness
(from case history)

Age Group	No. of Patients	Condition existed from birth	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
12-19	7	5				1	1					4	1																																																					
20-29	13		1		2	2	1	1	1			4	1																																																						
30-39	8	1						1		1		1	3		1	1																																																						
40-49	14	3			1	1				1		1	1	2	4			3																																																				
50-59	11	1	1	2						2		1	1	1		1	1				1																																																	
60-69	17		1	4	2				2	1		2	3		2																																																						
70-79	21		1		5	3	3		1	1		3		2	1		1																																																			
80-89	9		2		4		1						2																																																					

Totals 100 (10) 6 6 14 7 7 1 4 6 16 12 5 8 2 2 3 1

Median - Years of Partial Blindness 7.6 years

Table #2

Table 2 shows the wide and varied distribution of the number of years that the patients reported having had the condition of partial blindness.

Table 3 deals with rehabilitation visits. In the past, casual remarks made to those interested in subnormal vision, indicated that the greater percentage of patients needed 8 to 9 visits for rehabilitation. It was

No. of visits needed
for Rehabilitation

Age Group	No. of Patients	3	4	5	6	7	8	9	10	11	12	13	14	15
12-19	7	1	4	1		1								
20-29	13	1	5	3	3			1						
30-39	8			4	2		1	1						
40-49	14	1	3			1	4	2	2					1
50-59	11			4		2	2	1	2					
60-69	17		5	3	1	2		3	2		1			
70-79	21		3	5		2	2	4	1	3				1
80-89	9		3	1					1	1	3			

Totals 100 3 23 21 6 8 9 12 8 4 4 2

Median age for group 57.3 years
Median visits for group 6

Table #3

TABLE 4. VISUAL AIDS USED

Telescopic Spectacles	100
Microscopic Spectacles	
6 X	1
8 X	6
10 X	1
12 X	2
16 X	8

therefore revealing that the median for the entire group was 6 visits.

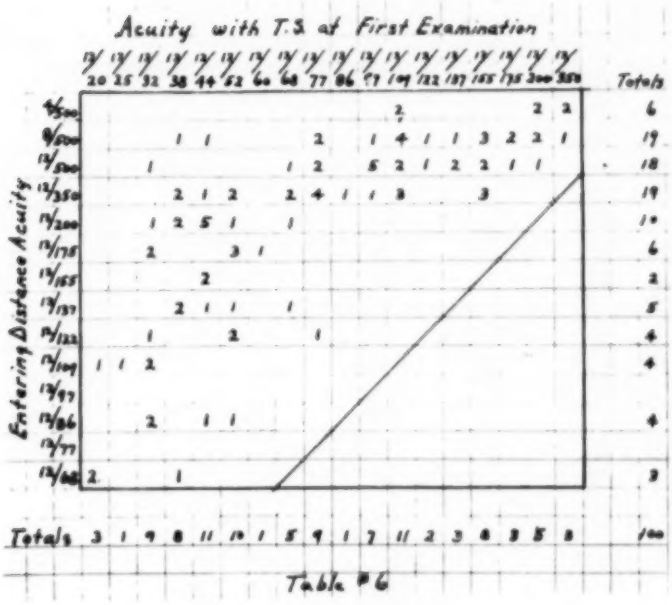
Table 4 shows the visual aids used, indicating that in addition to telescopic spectacles, microscopic spectacles were also supplied. When the visual acuity at near cannot be raised sufficiently with a reading add over the telescope, the writer uses the microscopic spectacle, which will usually enable the patient to read the smallest Jaeger. Experience has shown that any reading cap stronger than +12.00 is not practical or desirable although stronger adds have been used. The use of the M.S. offers a larger, flatter, more useful field of vision. There were 18 patients for whom microscopic spectacles were supplied in addition to the telescopics. It has been the writer's opinion for years, that the use of telescopic spectacles was a necessary theraputic device that has aided in building acuities. The only time a telescopic dummy lens is used, is for an eye that is blind. As long as there is any amount of measurable vision in the poorer eye, a regular unit is supplied. A dummy, to our mind, suggests hopelessness, and most patients seem to resent the use of a dummy.

Table 5 shows that half the group returned after two years. This does not indicate the number of years each patient has worn the

Elapsed Years between First and Last Examination

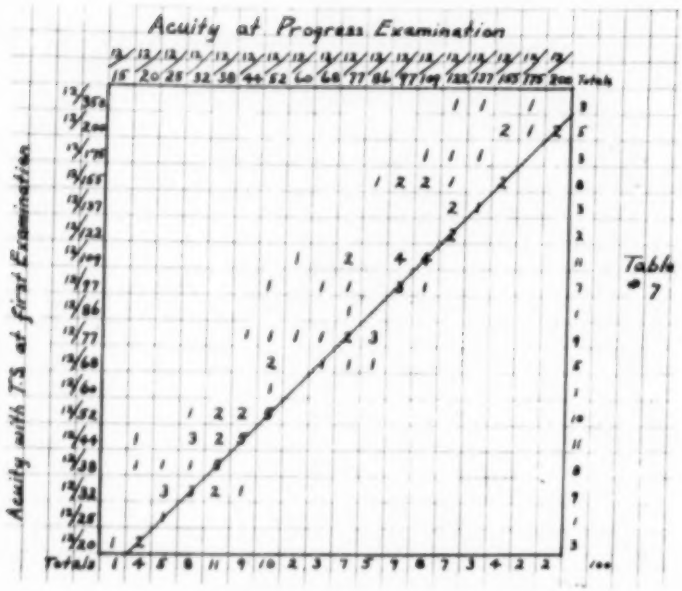
Major Pathology	No. of Patients	Less than 1 year	1 yr & less than 2 years	2 yrs. less than 3 years	3 yrs. less than 4 years	4 yrs. less than 5 years	5 yrs. less than 6 years	6 yrs. less than 7 years	7 yrs. less than 8 years	8 yrs. less than 9 years
Retinal-Choroidal	45	10	14	7	4	3		5	2	
Lens	24	6	7	4	2	1	1	2	1	
Optic Nerve	14	3	3		2	1	2	1	1	1
Glaucoma	9		4		1	1		1	2	
Cornea	3		1		1		1			
Idiopathic	4		1	1	1	1				
Physical/Anomaly	1		1							
Totals	100	19	31	12	11	7	4	9	6	1

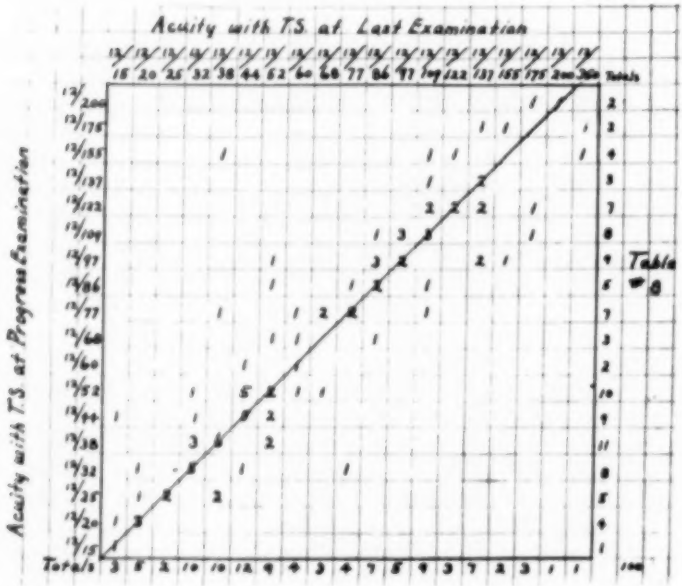
Table # 5



devices, since a large number of patients were seen years ago and were not heard from since.

Tables 6, 7, and 8, illustrate the changes from the starting distance visual acuity, through the progress check and the final acuity obtained. In Table 6, it is shown that 72 patients had a starting acuity of 12/200 or less, improved with telescopic spectacles so that only eight remain in the group of 12/200 and less. In Table 7, those cases shown above the diagonal line had increases in visual acuity beyond that obtained at the first examination. These increases may be directly attributable to the training period and this illustrates the importance of teaching the patient to use the device, to acquire certain new visual habits and most important, to form new memory pictures. It was during this period that those who had originally suffered psychic trauma and fear of blindness, made best progress because they had "now accepted a new program of work which seemed destined to aid them." Table 7 shows that 53 made additional gains, 9 dropped in acuity and 38 maintained the vision which they manifested when the telescopic unit was added in the subjective test during the first examination. In Table 8, data are presented to show that 40 patients made still further


Acuity at Progress Examination
Acuity with T.S. at first Examination
Totals
Table 7


Acuity with T.S. at Last Examination
Acuity with T.S. at Progress Examination
Totals
Table 8

gains in acuity beyond the treatment period, 39 held to the acuity achieved in the progress examination and 21 dropped below that shown at the time of the progress check. Withal, the losses were not too severe and at best represent a large improvement over that which they showed as entering acuity.

Table 9 illustrates in percentage form the increases in acuity obtained in the various age groups. These data would seem to suggest that age is not a factor. The computation of "r" yields a value which would indicate that there is no correlation between the age of the patient and the percentage of improvement.

TABLE 9. IMPROVEMENT IN VISUAL ACUITY IN %

Age Group	No. of Patients	Minimum	Maximum	Median
12-19	7	14.1	56.5	29.2
20-29	13	3.6	72.2	11.5
30-39	8	9.2	42.4	22.6
40-49	14	6.2	72.0	16.2
50-59	11	0.8	25.6	13.1
60-69	17	7.2	42.0	18.4
70-79	21	7.2	31.5	13.2
80-89	9	5.2	35.9	10.4
Totals	100	0.8	72.2	16.5

Table 10 shows the percentage of improvement for each pathological condition. These data indicate that the best results were obtained with retinal and lenticular anomalies, where the percentage of improvement averaged nearly 20 per cent. However, the application of statistical tests for the significance of the differences of these averages indicate that they are not significant and may be due to chance.

TABLE 10. IMPROVEMENT IN VISUAL ACUITY IN %

Major Pathology	No. of Patients	Minimum	Maximum	Median
Retinal-Choroidal	45	4.3	72.2	19.6
Lens	24	3.3	56.5	19.0
Optic Nerve	14	0.8	72.0	10.0
Glaucoma	9	7.2	69.0	10.4
Cornea	3	6.4	53.2	11.4
Idiopathic	4			
Physical Anomaly	1			
Totals	100	0.8	72.2	16.5

Table 11 presents the years of blindness, with percentage of improvement. Here we find that those who had been partially blind about 15 years made the best improvement and also required the least number of visits to effect rehabilitation. This group the writer believes has surmounted the stage of psychic trauma. They have been to numerous doctors who have told them "there is nothing that can be done" so that when relief is held out to them, there are fewer psychological

blocks to prevent their reeducation. Very few "dependent blind personalities" are found in this group. In addition this table shows that, there is no evidence of any correlation between the number of years of blindness and the number of visits required.

TABLE 11.

Years of Partial Blindness	No. of Patients	Total No. of Visits	Median No. of Visits	Median % of Improvement
0-4	33	201	5	14.3
5-9	18	115	7	13.2
10-14	16	106	7	17.1
15-19	12	63	5	25.6
20-24	5	46	10	14.3
25 and over	16	149	10	19.6
Totals	100	680	6	16.5

Table 12 is a further elaboration of Tables 6, 7, and 8, this time in percentage of improvement. This table seems to suggest that extensive improvement may be obtained for patients whose entering vision is 12/350 and better.

TABLE 12.

Entering Distance Acuity	No. of Patients	Median % of Improvement
4/500	6	8.5
8/500	19	9.4
12/500	18	10.0
12/350	19	19.6
12/200	10	25.6
12/175	6	30.7
12/155	2	26.8
12/137	5	18.6
12/122	4	17.9
12/109	4	32.5
12/97		
12/86	4	23.6
12/77		
12/68	3	42.4

Correlation coefficients were computed for the following relationships: the years of partial blindness and the per cent of improvement, the entering distance vision and the per cent of improvement, the age of the patient and the per cent of improvement, the years of blindness and the number of visits, and the entering vision and the number of visits, and in all five classifications no significant correlation was found to exist.

In considering the median indices shown in Tables 9, 10, 11, and 12, one should bear in mind the otherwise wide dispersion that exists between the minimal and maximal obtainable improvements in visual acuity.

To further aid in the interpretation of the medians, the standard errors were computed and found to be as follows:

Age	2.59 years
Years Partial Blind	1.42 years
Visits	0.35 visits
Per Cent Improvement	1.82%
Entering Acuity	0.51

CONCLUSION

This report suggests that in cases where the pathology was terminal, and the patients had used the devices as prescribed, there was a marked improvement in perspective outlook as well as in vision. Apparently the time factor is important in establishing the element of use in newly acquired skills. Time seems to permit the acquisition of new visual clues, the raising of the level of achievement, the reinforcement of the motor and intellectual level and the concommittant increase in visual acuity.

Those patients who showed losses in acuity were found to have descending pathology, disturbed psychogeny, or were not using the devices as originally suggested. The losses as such were only below the level of acuity developed at the time of the progress examination. The acuity of no patient dropped below that recorded at the first examination as the entering vision.

There is no evidence that the age of the patient, duration of blindness, or the type of pathology are significantly related in the determination of prognosis for those partially blind.*

*The writer wishes to acknowledge his indebtedness to George Kolker, C.P.A., and Murray Dorkin, Instructor in Statistics at Russell Sage College, Albany, N. Y., for their invaluable aid with the data disclosed in this study, and to Dr. William Feinbloom. His constant encouragement and criticism have made this work possible.

REFERENCES

1. Feinbloom, W. Report of 500 Cases of Subnormal Vision. Am. J. Optom. 12.6. 238-249. 1935.
2. Neill, J. C. The New Clear Image Lens. Penna. State Col. Optom. Alumni Bull. 6.6. 29-37. 1953.
3. Jaeckle, C. E. Subnormal Vision from Infancy. Am. J. Optom. 12.5. 195-207. 1935.
4. Vics, I. I. Comments on Psychosomatic Optometry with Reports of Subnormal Vision Cases. Am. J. Optom. & Arch. Am. Acad. Optom. 26.2. 57-68. 1949.
5. Freeman, E. Optometric Rehabilitation of the Partially Blind. A Report of 175 Cases. Am. J. Optom. & Arch. Am. Acad. Optom. 31.5. 230-238. 1954.
6. Feinbloom, W. A Study of Visual Rehabilitation After 30 Years of Braille. Am. J. Optom. 13. 8. 455-463. 1936.
7. Feinbloom, W. A Telescopic Magnifier for Incomplete Optic Nerve Atrophy. Am. J. Optom. & Arch. Am. Acad. Optom. 18.12. 550-558. 1941.
8. Feinbloom, W. A High Resolution Lens for the Partially Blind. Opt. J. & Rev. Optom. 90.1. 36-37. 1953.
9. Jaeckle, C. E. Restoration of Ability to Read with Either Eye After Training One Eye in a Case of Subnormal Vision. Am. J. Optom. 13.7. 266-272. 1936.

THE RELATIONSHIP BETWEEN ACCOMMODATION AND ACCOMMODATIVE CONVERGENCE*

Gerald Westheimer†
School of Optometry, The Ohio State University
Columbus, Ohio

It has been found experimentally that a change in the accommodative state of the eye is associated with a change in convergence when the two eyes are dissociated, and most of the evidence points to a linear relationship between accommodation and what has been called accommodative convergence.

The apparent linearity of the experimental plot of accommodation in diopters and accommodative convergence in prism units has been used on the one hand to develop a clinical system for the analysis of patients' near vision problems and on the other hand it has led to the use of a subject's fusion free convergence as a measure of his accommodative innervation.

A number of investigators have demonstrated that this relationship between accommodation and accommodative convergence, often called ACA, is characterized by a high degree of constancy in an individual, and consistent changes in the ACA with age are generally discounted.

We can only hypothesize concerning the neural pathways which would bring about such a relationship.

We may assume, on a first hypothesis, that there is a neural linkage by which the convergence center is activated along with the accommodation center every time an accommodative response is sought. In addition there are independent sources of stimulation of the convergence center. The linkage which ensures a convergence response with every accommodative response may be of a simple kind which would cause strictly parallel innervations to be sent in the direction of the two areas. For such a system to produce a linear relationship between accommodation (measured in diopters at the spectacle plane) and convergence (measured in prism units) it would be necessary for the two effector systems, the accommodation and the convergence systems, to be linear throughout.

---

*Read before the annual meeting of the American Academy of Optometry, Toronto, Ontario, Canada, December 11, 1954. For publication in the April, 1955, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY. The experimental work reported in this communication was carried out in the Vision Laboratory, University of Houston. Acknowledgment is made to Theron Baber, Thomas Riebe and Joe Ed Woods for their help.
†Optometrist, Ph.D. Member of Faculty, Fellow, American Academy of Optometry.

This means that, broadly speaking, one innervation unit should finally produce one diopter of accommodation and, say, five prism diopters of convergence: two innervation units should produce two diopters of accommodation and ten prism diopters of convergence, and so on.

An interesting experiment was recently carried out by Marg and his co-workers in which it was shown that this schema holds for at least a part of the accommodation system. On the whole, however, it has not been shown either theoretically or experimentally that the whole process follows this pattern. If one considers the complex nature of the two systems one is entitled to wonder just how such a linearity could be achieved. Is it by the fortuitous cancellation of several non-linearities? After all, accommodation, for example, is brought about by nerve action potentials reaching the ciliary body where they produce contraction of muscle fibers which release a system of elastic forces which in turn are responsible for a change in shape of the crystalline lens: and the change in optical properties of the eye is finally measured in diopters at the spectacle plane!

It becomes clear that neither the linear nature of the accommodation/accommodative convergence relationship nor its constancy is obvious. On the contrary, if such an analysis is correct one should expect to find variability of one form or another in the ACA, particularly with age. Nothing can be said *a priori* about the magnitude of such effects, but it is extremely unlikely that two linear systems would retain a constant relationship throughout the physiological changes that their effector systems are subjected to throughout life.

Essentially the same analysis would still hold if we considered systems of inbuilt non-linearities whose net effect would be to produce a final linear relationship. It is unlikely that such factors would retain this effect throughout life.

So far in this discussion we have considered an accommodation/accommodative convergence relationship due to a linkage at the top level only which leaves the effector systems independent of each other from there on. There is another theoretical possibility. It is feasible that there is a closed loop circuit involved which would serve to change the output of one of the functions to compensate for a lag in the output of the other. In other words, a feedback circuit may exist which keeps the ACA invariant. While anatomical evidence for such a linkage is lacking so far, continued observations of an invariance of the ACA with age, if they can be placed beyond any reasonable doubt, would strongly point to such a possibility.

To recapitulate: If there is a rigid linkage between accommo-

dation and accommodative convergence at a high neural level only (common original pathway) while the remainder of the two pathways are completely independent of one another, one may expect variation of the ACA with age and other factors, and a linear ACA is not automatically provided for. A high degree of constancy and linearity of the ACA, on the other hand, would point to the possibility of a feedback circuit adjusting for changes in the effector systems of the two functions.

This is certainly not the whole story. Changes in tonic convergence, several sources of innervation of the ciliary muscle and a host of other factors can conceivably complicate the analysis a good deal further. But even a relatively simple hypothesis concerning the linkage between accommodation and accommodative convergence still leads to a complicated set of problems.

It is obvious that the answer to some of the questions raised above must be sought experimentally. One approach, of course, is the neurophysiological one. We need not by any means suppose, however, that direct measurements of accommodation and convergence have yielded all the information that can possibly be extracted from them. Systematic studies should be undertaken to determine the effects of age, drugs, pathology, and so on, on the ACA. As a preliminary it must be determined with what precision the ACA can be measured so as to ensure that any conclusions drawn are statistically sound.

EXPERIMENTAL PROCEDURE

Two nearly emmetropic observers, in their early twenties, who had acquired some skill in taking measurements on the haploscope, were used in the experiments.

The University of California model of the haploscope, Figure 1, was employed to measure the accommodative response, as well as the accommodative convergence associated with it, to a series of 20/20 Snellen letters projected in a darkened room onto a screen at 6 meters from the observer. Progressively stronger pairs of minus lenses from one to five diopters in diopter steps were placed before the eyes and about five measurements of accommodation and accommodative convergence were taken under each of the conditions. A pair of artificial pupils 3 mm. in diameter was placed in the cells of the haploscope. One eye was used for fixation of the Snellen letters as well as for measurements of the accommodative response. The other eye was used for phoria measurements and also for accommodation measurements, but the records of the latter measurements are not considered in this paper. All measurements were obtained in a single session.

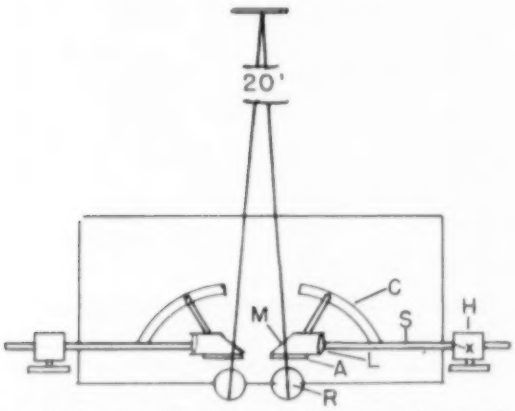


Figure 1. Schematic drawing of haploscope used in present investigation. L, lens of haploscope which images target X on retina. X is a small spot of light which can be moved along arm, S, of haploscope by means of a rack and pinion device. H. Accommodative response is thus measured by means of stigmatoscopy. The arm, S, can be moved around the center of rotation of the eye, R, and the amount of accommodative convergence is measured on scale, C. M is a semi-silvered mirror which permits the stigmatoscope target X and the Snellen letters at 20' to be seen simultaneously. The other eye only sees the stigmatoscope spot on the other arm. A is a lens cell.

Precision of a single accommodation/accommodative convergence measurement: With the haploscope used in the experiment and with a skilled observer it is possible to assign the precision of at best about plus or minus 0.25 D to a single accommodation measurement and about plus or minus ¼ Δ to a convergence measurement. This means that a single measurement which is shown as a dot in the accompanying diagrams should be represented by a probability rectangle centered around the indicated spot. The extent of the area is of the order mentioned above. While it is possible to refine the processes of measurement to some extent, it is my belief that it is unlikely that a simultaneous set of measurements of accommodation and convergence can be obtained with a very much better precision than above stated.

RESULTS

The results are presented in the accompanying Figures. Figure 2 shows the results for observer T.R., whose age is 20, on two different occasions several months apart. Each of the two sets of results was obtained in one session so that the variability due to the subject's changes from day to day may be supposed to have been minimized. Constancy of pupil size and observation distance have also eliminated other sources of variability.

It will be observed that this subject shows decided non-linearity

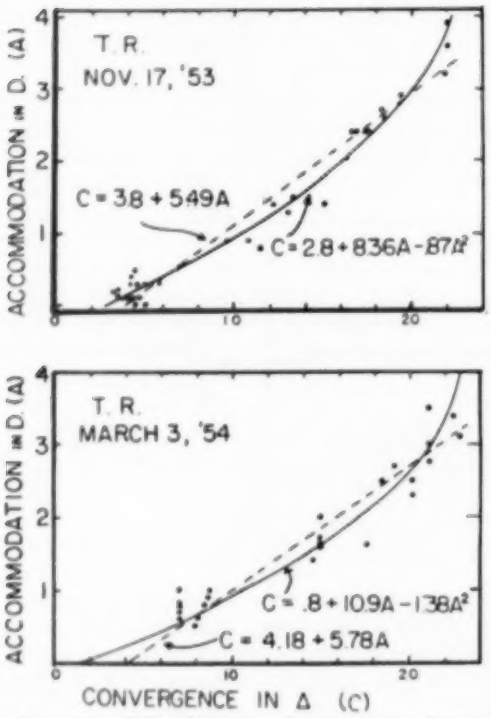


Figure 2. Data for subject T.R. Abscissae: Accommodative Convergence in Prism Diopters. Ordinates: Accommodative Response in Diopters.

of the section of the accommodation/accommodative convergence relationship investigated and that the curvature of the graph did not change very much from one series of measurements to the other. Both the best fitting straight line and the best fitting quadratic are shown in the Figures. In all cases where a quadratic has been fitted, the sum of squares of the measurements from it is significantly smaller than the sum of squares around the best fitting straight line (at the 1% level of significance). No particular theoretical construct will be built around this finding in this paper, but it should be pointed out that the curvilinearity found in subject T.R. appears to be both significant and constant.

Figure 3 shows the same type of information for subject J.W., aged 22. It will be observed that while the general outline of the relationship has not changed from one set of measurements to the other,

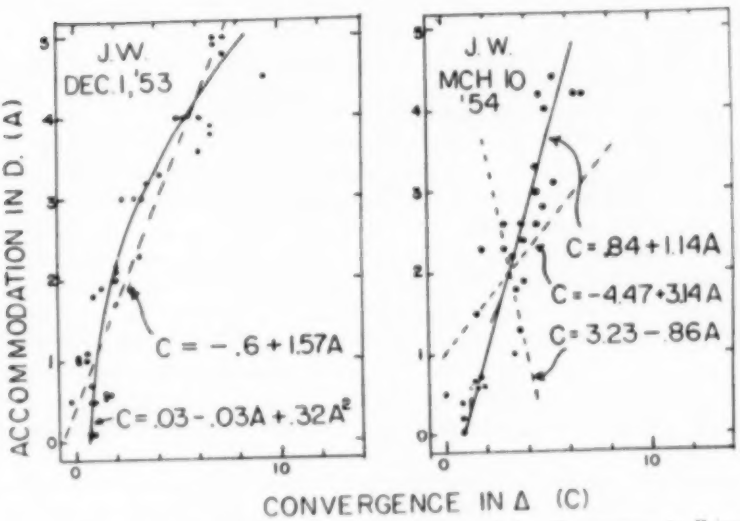


Figure 3. Data for subject J.W. Abscissae: Accommodative Convergence in Prism Diopters. Ordinates: Accommodative Response in Diopters.

the second series does not show the curvilinearity noted in the first. In fact, the best fitting equation for the second set of data is the simple regression equation

$$C = 0.84 + 1.14\ A$$

where C is the convergence in prism diopters when A diopters of accommodation are in play. The coefficient of A, 1.14, is the ACA of the subject. While this is the best-fitting straight line, it is obvious that there is considerable scatter around this line. This may be expressed by the standard deviation of the regression coefficient so that it becomes possible to determine a confidence interval for the latter. When this is done for the data on the right side of Figure 3, the standard deviation of the regression coefficient becomes 0.965 prism diopters per diopter (ACA units) and the 95% confidence range will extend approximately two ACA units on either side of the determined mean value. The two dotted lines in the figure graphically depict this confidence range.

Standard deviations for the data in the other cases are: T.R., Nov. 17, 0.975 Δ/D.; March 3, 1.1 Δ/D.; J.W., Dec. 1, 0.42 Δ/D.

That the 95% confidence limits for the ACA are not extreme may be seen in the data in which many pairs of points, if taken by themselves, would yield ACAs even further removed from the mean values.

COMMENTS

In the present experiment it has been found that even with a skilled observer taking 30 measurements on a haploscope in one session, with observation distance and pupil size controlled, it is not possible to assign to the ACA a 95% confidence interval of less than 2 to 4 ACA units. The clinical implications of this finding will not be elaborated here.

In connection with the questions raised in the first part of this paper it becomes clear that it is not easy to prove or disprove a theory of the relationship between accommodation and accommodative convergence. In any attempt to do so, cognizance must be taken of the scatter of the data points upon which the evaluation of the ACA ratio is based as well as the possibility of relationships which are not linear.

It should be understood that the experimental data presented in this paper are not intended to show that the ACA is necessarily non-linear. Under those circumstances in which we are trying to make predictions with a minimum of information, as is the case in clinical practice, the assumption of a linear relationship is undoubtedly the best. But in discussions in which more far-reaching conclusions are drawn, such as are involved in theories concerning the nature and stability of the neural linkage between the two functions, this cannot be taken for granted and, in fact, deviations from linearity may constitute an important clue in the search for the underlying mechanism.

SUMMARY

Possible neurological mechanisms accounting for the relationship between accommodation and accommodative convergence are discussed and their consequences analyzed.

Experimentally it was found that two skilled observers taking 30 measurements on a haploscope in one session, with pupil size and observation distance controlled, yielded determinations of their ACA ratios having 95% confidence limits of 2 to 4 Δ/D. Moreover, it was found that one of the two observers had a non-linear relationship which remained constant during a four month period.

It is concluded that careful statistical studies are required before ACA measurements can be used to develop or support theories concerning the nature and stability of the accommodation/accommodative convergence relationship and that the possibility of non-linearities in such relationships cannot be overlooked.

AMERICAN JOURNAL OF OPTOMETRY
and ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY
Established 1924

Vol. 32 April, 1955 No. 4

EDITORS AND STAFF

Dr. Carel C. Koch ..... *Editor*
Dr. Monroe J. Hirsch ..... *Associate Editor*
Dr. Rudolph Ehrenberg ..... *Associate Editor*
Dr. Kalvin L. Blodgett ..... *Assistant Editor*
Terry Judith Parkins ..... *Editorial Assistant*
William Moran ..... *Advertising and Production Manager*
Mary L. Kerr ..... *Circulation Manager*

Publication and Academy Office: 1502 Foshay Tower, 821 Marquette Ave.
Minneapolis 2, Minnesota

Annual Subscription, United States and Canada, $6.00 in Advance; Foreign, $6.50; Single Copies 60c

Original papers, scientific communications, clinical reports, books for review, and correspondence should be sent to the editor. Subscriptions and applications for single copies should be addressed to the circulation manager. Copy of advertisements must be sent in by the first of the month preceding their appearance. Communications with reference to advertising or other journal business should be addressed to the advertising manager. Academy correspondence should be addressed to Dr. Carel C. Koch, Secretary of the American Academy of Optometry.

Published Monthly by the
AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION

The American Academy of Optometry and the publishers of this journal have no objection to the reprinting by other magazines of any of the articles in this issue, provided such reprints are properly credited to the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

ACADEMY POST-GRADUATE COURSES

In the January, 1955, issue of this Journal there appeared an important statement on the action of the Executive Council relative to Academy Sponsored Post-graduate Courses. In it an explanation of the intent and objective of the courses was provided. Now, a further description of the courses, especially with relationship to other types of post-graduate instruction is made as well as a spelling out of the plan for 1955.

At the very outset, it should be understood that the courses will not supplant any portion of the regular annual meeting of the Academy. Rather, they are only supplementary, and an addition to the regular meeting. As in the past, the regular meeting will consist of business sessions, scientific reports and sectional meetings.

The courses are designed to compliment rather than compete with programs of post-graduate education by the various schools and colleges of optometry or with state or national organizations or inde-

pendant groups promoting post-graduate optometric instruction. The Academy courses represent a new and different approach: in them, a very wide variety of subjects will be offered with participation of a large number of instructors.

The post-graduate courses will emphasize time proven principles, data and techniques: in keeping with precedence, original papers, new data and research, and reports of investigations first must be presented in the general, open scientific sessions of the annual meeting.

Also, in the courses, practical, clinical data and methods especially will be emphasized. However, principles, concepts, hypotheses and ideas — those abstractions on which knowledge is built and on which it grows — all will be included.

With the foregoing explanation as background, a description of the plan of the courses for 1955 now is in order.

SCHEDULE OF COURSES

The courses will vary in length from one to twelve clock hours. In order to achieve a wide selection, an attempt will be made to keep the courses as short as possible. For courses exceeding six hours, there will be participation of more than one instructor. At the present, it is felt that all courses probably can be offered in two days preceding the regular annual meeting: if necessary due to the number and length of the courses, three days will be used.

NATURE OF COURSES

The practical as well as theoretical aspects of subjects and problems will be emphasized in the courses. Since practicing optometrists principally will be enrolled, an attempt always will be made to have a large number of courses that basically are clinical in nature. However, for those who aspire for the more abstract and theoretical approach, courses will be available to meet their needs.

Although no specific courses have been designed to date, the following list is a suggestion of their possible scope and variety:

Streak retinoscopy
Graphic analysis
Introduction to aniseikonia
Vision of premature infants
Design and Fitting of microlenses
Perceptual constancy
Vision in industry
Correction of vertical prismatic imbalance
Problems of aphakia
Advances in subnormal vision

Mathematics of ophthalmic lenses
Fundamentals of illumination
Design of multifocal lenses
Vision in schools
Visual screening
Binocular vision
Recent advances in optometry
Optics of the eye
Fusional movements
Testing of color vision

FEES

Unless otherwise indicated a standard fee of $2.00 per hour per person will be charged for each course.

ELIGIBILITY

Any optometrist, regardless whether he is an Academy member or not is eligible for enrollment in the courses. This policy is in keeping with the objective of the Academy always to increase and enrich the background of members of the profession. However, since the courses are Academy sponsored, members of the Academy always will have first choice.

ENROLLMENT

Depending on the nature of the course, enrollment will vary. For a laboratory course on the fitting of micro-corneal lenses, enrollment might be restricted to ten. For a lecture course on non-commitant strabismus by a number of instructors enrollment might be limited to one hundred. For all courses, the final decision will be made by the instructor in charge and the chairmen of the committees on instruction and administration of the courses.

If enrollment in any course was considered inadequate, it would be the prerogative of the Academy to cancel the course. However, a course can not be cancelled within two weeks from it's scheduled commencement.

INSTRUCTORS

Any member of the American Academy of Optometry can qualify as an instructor and offer one or more courses. By this means, it is hoped that the reservoir of wisdom, knowledge, skills and methods of members in the Academy will be readily available to all optometrists.

V. J. ELLERBROCK*

*Chairman, Committee on Instruction, American Academy of Optometry.

THE RESULTS OF MISCHIEF-MAKING IN THE EYE FIELD

Good honest differences of opinion presented in a spirit free from animosity and in the effort to achieve progress are beneficial to the growth of a profession. However, there are a few individuals in the field of eye care who enjoy mischief-making. These people have been busy during the past year or two, and the baneful results of their actions are becoming apparent. For instance, during the past month the committee representing the parent body in ophthalmology has withdrawn its support of the National Committee on Eye Care, and there are evidences that even more serious moves are in the offing. These happenings are the destructive result of deliberate attempts to arouse the emotions of distrust and fear.[1] All this goes on in spite of the arduous fight Dr. Samuel L. Brown, president of the American Optometric Association, is making for rational thinking and cooperation. The dissenters, and all groups have some of them, continue to rock the boat.

In the effort to place the issues squarely before optometrists, ophthalmologists and dispensing opticians, Dr. Brown recently said[2] "The basic objective of the A.O.A. resolution [under discussion] was to urge states to obtain stronger laws and better enforcement of prohibitions against laymen engaging in vision training and prescribing and fitting contact lenses.

"Despite widely publicized statements to the contrary, optometry certainly has no intention of attempting to invade the ophthalmological field. The evidence of this fact is quite clear when a review is made of the subjects taught in our five-year college courses. In addition, the A.O.A. is on record as welcoming professional relationship of the highest order with ophthalmology in the patient's best interests.

"As far as dispensing opticians are concerned, two facts speak for themselves: first, the A.O.A. is on record assuring ophthalmology that it in no way wishes to interfere with ophthalmology's relationship with dispensing opticians; and secondly—it is on record in declaring it to be unethical for members to hold themselves out to fill ophthalmic prescriptions not written by themselves.

"We are on record as strongly opposed and protesting against the unsupervised practice of technicians fitting contact lenses and/or prescribing and doing orthoptic training. We firmly believe technicians

[1]A most recent illustration is the editorial by Dr. Derrick Vail, ophthalmologist. This editorial was headed "Unmasked" and appeared in the American Journal of Ophthalmology, 39.3.425, 1955. Other similar examples have appeared recently in certain optometric publications and in the trade press serving dispensing opticianry.
[2]Optometry's Position in Vision Care Officially Defined. Editorial. The Journal of the American Optometric Association. 26.8.440. 1955.

in these fields should only practice under the immediate and careful supervision of an ophthalmologist or optometrist.

"We seek harmony in the vision care field and consider this essential to public welfare as well as optometry, ophthalmology and opticianry."

Dr. Brown is doing a most difficult job as president of the A.O.A. and he deserves the fullest support of all those engaged in the field of eye care. The time has come for these mischief-makers to seriously review the consequences of their work, and for them to realize the harm which will come to patients through their stirring up friction between the professions.

CAREL C. KOCH

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

ACADEMY LUNCHEON AT MILWAUKEE

As usual, the American Academy of Optometry will sponsor a luncheon for members and guests during the annual Congress of the American Optometric Association. This year the Luncheon will be held, Friday, July 8, 1955, at the Schroeder Hotel, Milwaukee, Wisconsin. All Academy members are welcome and should plan to attend the A.O.A. Congress and also be present at the special Academy luncheon. President, Dr. John D. Perry, Jr., will preside over this summer get-together.

CHAPTER ACTIVITIES

The New York Academy of Optometry conferred Honorary Memberships upon the following distinguished ophthalmologists, Dr. Isaac Don Spivack, Dr. Harold Noyes and Dr. Joseph I. Pascal at its March 15 meeting. These men were honored for the service they had rendered in their contributions towards the development of the optometric profession. The speaker of the evening was Professor Isidore Finkelstein of Columbia University who spoke on anomolous projection. The meeting was held at the Midston House, New York City.

The Indiana Chapter, American Academy of Optometry has announced a grant-in-aid in the amount of $50.00 to the Division of Optometry, Indiana University in support of a research project on the speed of accommodation. The project is under the direction of Professor Merrill J. Allen.

The following officers were elected at the February meeting of the Illinois Chapter, American Academy of Optometry. Dr. Richard Feinberg, Chicago, president. Dr. Eugene W. Strawn, Freeport, vice-president, and Dr. Grace Stevesson, Chicago, Secretary-treasurer. The officers and Dr. Morton Abram, Chicago; Dr. A. R. Rochte, Park Ridge and Dr. Frederick Kushner, Chicago, will constitute the executive council. Named on the program committee are Dr. Kushner and Dr. George Jessen, Chicago.

Dr. Gordon E. Lewis, Pasadena, was the speaker at the February meeting of the Southern California Chapter, American Academy of Optometry at the Los Angeles Athletic Club. His topic, illustrated with colored steroscopic slides, was Optometric Practices in Europe.

Professor Gerhard A. Brecher, M.D., Western Reserve University, was the speaker at the March meeting of the Northeastern Ohio Chapter, American Academy of Optometry. His topic was Visual Physiology and Psychology. The meeting was held at Hotel Cleveland, Cleveland, Ohio.

CURRENT COMMENTS

Terry Judith Parkins
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

HENNEPIN COUNTY WELFARE BOARD FEE SCHEDULE

The following fee schedule was adopted November 1, 1954, by the Hennepin County Welfare Board. This schedule covers eye examining and refracting, dispensing and supplying ophthalmic materials. All welfare cases in Minneapolis and Hennepin County are covered and the fees relate to work done by optometrists, ophthalmologists and dispensing opticians. All welfare clients when applying as patients for eye care are covered by this schedule, and are permitted a free choice of doctor or dispensing optician. Optometrists or ophthalmologists who do their own dispensing may do so.

Fee for eye examination and complete visual analysis, including proof of or verification of the completed prescription. . . . $8.35.

Dispensing fee, which includes facial measuring, adapting, adjusting, and dispensing of new glasses, and whatever number of future adjustments are necessary for the life of glasses. . . . $5.00.

Materials (frames and lenses) to be billed to the agency at the

actual prescription laboratory cost to the refractionist. Cost of frames not to exceed $7.50. . . . Actual prescription laboratory cost.

As regards repair work, when replacing one or both lenses, a front or complete frame, the welfare agency should be billed the amount of the dispensing fee ($5.00) plus actual prescription laboratory cost of materials. Replacement of temples should be done at laboratory cost.

A laboratory invoice (including cost of a case which the laboratory supplies) should accompany the statement to the welfare agency.

A special note to those who do their own laboratory work. It is the opinion of the welfare board on this schedule, that all prescriptions be filled by a recognized laboratory, so that the laboratory invoice may accompany the doctor statement for his fees, or the statement for the dispensing fee as supplied the welfare board by the doctor or the dispensing optician.

B.V.I. CAMPAIGN GETS UNDERWAY

Full page ads in the April issue of VOGUE and in the March 26 issue of the SATURDAY EVENING POST opened the new B.V.I. campaign to encourage more and better eye care. Both ads were real attention getters and were beautifully executed. The VOGUE ad "Eye Fashion Is High Fashion" was done in color and in the best of taste. The POST ad, entitled "Now is the time to have your vision checked!" carried a real punch. The current series of ads is off to a fine start and the Better Vision Institute is again doing a job of great value to us all in optometry.

ELLERBROCK RECEIVES NATIONAL COUNCIL GRANT

Among the 1954-55 research awards of the National Council to Combat Blindness, Inc., is an award to Vincent J. Ellerbrock, Ph.D., Associate Professor at the Ohio State University, and Director of the Optometric Clinic, including General Clinic and Special Clinic of Contact Lenses, Subnormal Vision, and Aniseikonia.

He is Director of the Department's Post Graduate courses, Annual Spring Conferences, and Museum of Visual Sciences.

Dr. Ellerbrock was born March 13, 1918; received his B.S. in Optometry at Ohio State University as well as his Master of Sciences in Physiological Optics, and Doctor of Philosophy in Physiological Optics.

The Members of the Scientific Advisory Committee of the National Council to Combat Blindness awarded him a grant-in-aid for the "Preparation of a volume on subnormal vision: evaluating the aids currently available for subnormal vision, and making recommendations for the development of new aids."

It was felt by the Committee that such a book is timely and should prove of great value to educators, school administrators, optometrists, physicians, and others concerned with the care and the treatment of the partially sighted.

HEALTH CAREERS GUIDEBOOK

A section on optometry appears in *Health Careers Guidebook* which has just been published by the National Health Council. The 160-page guidebook covers 156 occupations in the health field from hospital maintenance to creative scientific research. The optometry section was developed in cooperation with the A.O.A., and readers are referred to the A.O.A. for additional information.

The project was supported by the Equitable Life Assurance Society of the United States. Copies of the guidebook will be distributed without cost to all the 29,000 secondary schools and junior colleges in the United States to reach 7½ million teen-age students. Educational requirements, personality traits, income opportunities, and other basic information important to youth are covered in the optometry section.

The National Health Council is a public service organization made up of associations in the health field, and the guidebook is the first step in the new Health Career Horizons Project.

NATIONAL BOARD APPLICATIONS AVAILABLE

Supplies of National Board examination application forms have been sent to the Deans and Directors of the schools and colleges of optometry, it was announced by Dr. John R. Uglum, Secretary. Applicants may obtain forms either from their school offices or from the Secretary, Crow Building, Mitchell, South Dakota. These must be filed not later than May 24 for the examinations to be given on June 23-25 in the cities of New York, Boston, Philadelphia, Columbus, Chicago, Memphis, Houston, Los Angeles, Berkeley, and Forest Grove.

NEWS RRIEFS

The Titmus Optical Company, Petersburg, Virginia, is offering a $1,000.00 prize for the name selected that best describes the function of its line of single vision corrected curve lenses. All persons in the field of eye care may enter the contest. . . . The award of, Officer of the Order of the Bristish Empire, has been conferred on Mr. George H. Giles, optometrist, London, England, in the last Government Honors List. Academy members everywhere congratulate their distinguished colleague on the much deserved honor. Mr. Giles is editor of the DIOPTRIC NEWS and secretary of the British Optical Association. . . . The Central Atlantic Optometric Assembly will be held at the Ritz-

Carlton Hotel, Atlantic City, May 28-30. Dr. George L. Brown is general chairman. . . . Mr. Beverly Chew, chairman of the board, Shuron Optical Company, Geneva, New York, received a testimonial banquet and award certificate from the Optical Manufacturers Association for his work in organizing the 1954 Optical Fair held in Chicago. . . . Dr. R. E. Robinson, secretary of the Nevada State Optometric Association reports that the annual meeting of the association is scheduled in the rebuilt New Frontier Hotel, Las Vegas, Nevada, April 22-24. Convention guests may visit the Fabulous Strip of Las Vegas where the top entertainment of the country performs nightly. . . . Mr. William W. McQuilkin was elected vice-president of the Bausch and Lomb Optical Company, Rochester, New York at the annual stockholders meeting March 28. The company has also announced a new and more accurate Model 70 Vertometer for use by optometrists in neutralizing lenses.

April 20-21 are the scheduled dates of the post-graduate optometric courses at the College of Optometry, University of Houston. A number of specialized two-hour clinical courses have been planned by the faculty for optometrists who are expected to come to Houston from all parts of the southwest. . . . Mr. H. Stanley, chairman of the board, Univis Lens Company, Dayton, Ohio, announces that management principals have acquired a controlling interest in the Company, through the purchase of all Univis stock holdings of the Stanley family. The purchasers of the stock are Mr. Gerald F. Weis, president; Mr. R. O. Barber, first vice-president; Mr. S. A. Emerson, vice-president for research and Mr. A. J. Sowers, vice-president and treasurer. The purchasers will continue to operate the Company. Mr. Stanley remains as a member of the board. . . . Dr. Thaddeus R. Murroughs, Evanston, Illinois, will present a Basic Visual Training Course, June 8-11, and an Institute on Strabismus and Amblyopia, June 12-16 in Washington, D. C. For information on fees and registration optometrists are requested to write to Dr. R. A. Kraskin, 900 F St. N. W., Washington, D. C. . . . The Los Angeles College of Optometry has purchased additional property adjacent to the present campus for the construction of a new clinic building. . . . Dr. Howard F. Haines, clinical instructor, School of Optometry, The Ohio State University, Columbus, Ohio, spoke on Aids for Children with Sub-Normal Vision at the 1955 Conference of the National Society for the Prevention of Blindness, New York City, March 16. At this meeting Dr. J. T. Lanman, professor of pediatrics at the New York University-Bellevue Medical Center pointed out that there were now an estimated 6,000 children in the U. S. A., who were blind from retrolental fibroplasia. . . . Dr.

T. N Greenstein, clinical associate, Pacific University, College of Optometry, was appointed a delegate to the national convention of the International Council for Exceptional Children, Long Beach, California, April 11-16.

Dr. E. B. Park of Chanute, Kansas, has joined the faculty of the Southern College of Optometry, Memphis, Tennessee. . . . Dr. Harold Simmerman, of the faculty, Pennsylvania State College of Optometry will lecture on visual fields on April 27 at the Rutgers Engineering Building Auditorium, Bleecker Place Campus, New Brunswick, New Jersey. The meeting will start at 1:30 P. M. All optometrists are invited. The meeting is under the supervision of the New Jersey Optometric Association. . . . The speakers at the 15th Southwestern Congress of Optometry were Dr. Emmett A. Betts, Director of the Betts Reading Clinic, Haverford, Pennsylvania; Dr. A. M. Skeffington, Educational Director of the Optometric Extension Program; Dr. B. R. Wolff, Cincinnati and Dr. W. R. Henry, Warrensburg, Missouri. The Congress was held at Forth Worth, Texas. . . . Dr. Bernard Vodnoy, South Bend, Indiana, presented a Visual Training Seminar before the Southwestern Michigan Optometric Association at Niles, Michigan. . . . The annual meeting of the Minnesota State Optometric Association is scheduled for the Lowry Hotel, St. Paul, April 24-26. The speakers will be Dr. Eric Fantl, ophthalmologist faculty member of Chicago College of Optometry who will speak on ocular pathology and visual fields, and Dr. Don A. Frantz, DeKalb, Illinois, who will speak on patient control. . . . Mr. Stanley Tanaka, Honolulu, a second year student at the Northern Illinois College of Optometry was the recipient of the College, William E. Malinka award. This award is presented each year to the student with the highest grade point average for his first year of undergraduate professional work in the college. . . . Word has just arrived that the United States Supreme Court upheld optometry in the Oklahoma case that has been in Washington since last Fall. This litigation had to do with Oklahoma legislation that will improve the conduct of certain dispensing opticians in that State, and the decision may also have a marked effect upon some of them elsewhere. In certain areas there is much room for improvement. . . . Mr. Walter A. Stewart, 65, a long time supporter of professional optometry and president of the American Optical Company has retired in accordance with company policy. Mr. E. Weldon Schumacher, 46, has been elected president of the company. Mr. Schumacher has been vice president since 1953. He is a graduate of Carnegie Institute of Technology and the Harvard Graduate School of Business Administration.

Year after year, Therminon Ophthalmic Lenses provide the perfect QUALITY *your professional standards demand because they come...*

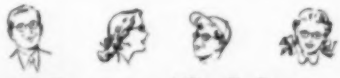
FROM THE HANDS OF CRAFTSMEN

A statement of product-integrity from William Crawford (left), vice-president, Therminon Lens Corporation: "We regard your prescription for Therminon Lenses as a demand upon us for the finest ophthalmic lenses in America. We are constantly aware that the quality of our lenses must reflect the highest standards of the profession we are proud to serve."

Therminon Lens Corporation

63rd and University Ave. Des Moines, Iowa

SINGLE VISION • KRYPTOK
"A" BIFOCAL • F-T BIFOCAL



for 9 out of 10– the prescription IS available in I-GARD plastic lenses

Many examiners are surprised and pleased to learn that more than 90% of their prescription requirements can now be met with beautiful, clear-vision I-GARD plastic lenses, often right out of stock for immediate delivery.

I-GARD Rx service now includes: S.V. lenses in quarter diopter steps, minus on plus up to −16.00 +6.00, plus on plus up to +9.00 +6.00. Bifocals in a new range of spheres up to +10.00 and lenticular bifocals up to a +20.00 −6.00. A wide range of single vision lenticulars in plus up to +20.00 −6.00 and minus up to −21.00 +6.00. Prism and absorptive shades available in all types.

Send for Foci Charts, price list, samples and name of nearest I-Gard distributor.

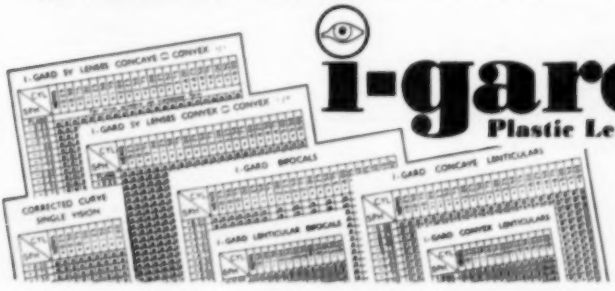
Dept. F, **McLEOD** OPTICAL CO., INC. 357 Westminster St., Providence 1, R. I.

really Feather-Light

really Non-Shatterable

i-gard

Worn by millions all over the world



i-gard Plastic Lenses

UNIVIS

nu-line© 7 CV

TRADE MARK

patent pending

ready now for your Rx

80% less reflection off segment lines.

Popular segment sizes—7mm. intermediate, 23mm. segment width.

Inconspicuous segments blend into facial coloring.

Positive identification through treated lines.

Johnson Optical Co.

BRANCH LABORATORY
526 Board of Trade Bldg., Duluth, Minn.

MAIN OFFICE AND LABORATORY
301 Physicians & Surgeons Bldg., Minneapolis, Minn. BR. 3193

New Glover FRAMETAINER

exclusive in Glover FRAME CABINETS

Classifies 144, 96 or 48 frames at your fingertips.

We're glad to send you complete information on the items checked.

☐ Glover FRAME CABINETS

☐ Glover FITTING DESKS

☐ Glover FRAME PANELS and TILES for office wall frame presentation.

☐ Glover Plan for Correlated Frame Dispensing.

Recommended by your optical supply house.

GLOVER

P. O. BOX 4093
AUSTIN 31, TEXAS

LEADING DESIGNER AND MANUFACTURER OF OPTICAL FRAME DISPENSING EQUIPMENT SINCE 1931.

COPYRIGHT 1955 BY A. D. GLOVER—A. J. OF O.

WALCO

SINCE 1915

COMPLETE OPHTHALMIC

Services

to the PROFESSION

☆ Precision GRINDING
☆ Quality MATERIALS
☆ Craftsmanship

CONVENIENTLY LOCATED
St. Paul, Minn. • Austin, Minn. • Bemidji, Minn.
Watertown, S.D. • Grand Forks, N.D. • Billings, Mont.

THE WALMAN OPTICAL COMPANY
329 Medical Arts Building Minneapolis 2, Minnesota
FOUNDED IN NINETEEN HUNDRED FIFTEEN

TWO OF THE FINEST FRAMES

ART-RIM

LEADING LADY

There's an air of elegance about the Art-Rim Leading Lady that accounts for its wide popularity as a frame for women. New patterned zyls and rich solid colors offer a wide range in fitting. Available in a variety of beautiful trims. Model shown with Royal Baguette trim.

Colors: Briartone, Demi-Blonde, Bronze, Blue Mesh, Coca Mesh, Black Marble, Black & White, Black & Pink, Blue Slate & White.

7m DIFF.

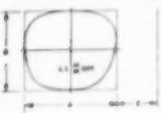
Eye	A	B	E BRIDGE
40	42.5	34.5	18-20-22
42	43.5	36.5	18-20-22-24
44	45.5	38.5	18-20-22-24
46	47.5	40.5	18-20-22-24

P.D. — A + E 42.5 + 20 — 62.5 P.D.

TOWNSMAN

The "go-with everything" rightness of the Art-Rim Townsman is an important factor in its universal appeal. its distinctive, clean-cut, casual styling blends with all the clothes and pursuits of daily living. Rarely does a single frame offer such complete satisfaction . . . for patient . . . for you!

Colors: Briartone, Grey Slate, Gunner Brown.



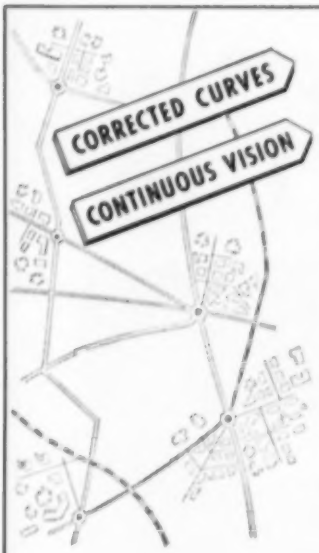
EYE	A	B	E BRIDGE
42	43	36.5	20-22-24
44	45	38.5	20-22-24
46	47	40.5	20-22-24
48	49	42.5	20-22-24

P.D. — A + E 42 + 20 — 62 P.D.
Available in Briartone, Demi Blonde, Gunner Brown and Grey Slate

Minnesota Optical Company

REgent 7297

621 West Lake Street **Minneapolis 8, Minnesota**



Where do the roads of ophthalmic progress lead?

Scientific progress shows the right roads ahead more clearly with each passing year. This has been particularly true in the ophthalmic field. Those laboratories which have used only the quality products of the progressive manufacturer have found that they benefit and build both themselves and the doctors whom they serve.

This has certainly been true in the case of corrected curve lenses. Progressive laboratories everywhere stress their use—and they mean even more to the doctor and his patients. We lend our voice strongly to this suggestion. It is our firm belief that we serve better by supporting such recommendations.

We also add our voice to those of the increasing numbers who are advising the prescription of Continuous Vision Lenses in the practice of eye care. Produced on the excellent Univis Series of Corrected Curves, CVs represent the ultimate in performance for a substantial percentage of presbyopic prescriptions.

A COMPLETE Rx SERVICE

Twin City OPTICAL COMPANY

MINNEAPOLIS • MINNESOTA WILLMAR

P. A. B. S.

An Authorized Binding
for

AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY

Arrangements have been made by The American Academy of Optometry for subscribers to have their journals bound into distinctively designed books.

Twelve issues, January through December, bound in best grade dark spruce washable buckram, imprinted with your name on cover, cost but $3.45 per volume.

Bound journals serve as an immediate reference for research and information. Properly displayed, they create a psychological impact on the patient, implying the time and effort spent to keep up-to-date on the most modern techniques and treatments.

Ship journals parcel post. Within thirty days after receipts, bound volumes will be shipped prepaid anywhere in the U.S.A. Full remittance must accompany order.

PUBLISHERS' AUTHORIZED BINDERY SERVICE

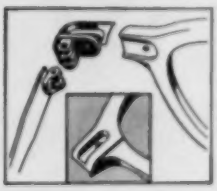
(Binders of all Journals)

308 West Randolph Street Chicago 6, Illinois

• UNIVIS B • UNIVIS R • UNIVIS D-28 • UNIVIS CV-6 • NU-LINE 7 CV • VOCATIONAL CV • SINGLE VISION CATARACT • "D" SEG CATARACT • UNIVIS D • TRIFOKAT • BIFOKAT • LENTICULAR "D" • LENTICULAR "T" • DOUBLE D •

Nothing could be more Masculon™

A lightweight frame — yes, for greatest comfort to the wearer. But they're designed with men in mind. They're sturdy, all-male, with a pleasing eye shape and a unique contoured bridge which flatters most facial features and distributes weight evenly. Wide color range, too!



NEW *about Masculon*

1. Precision machine-slotted end piece for greatest strength—eliminates rocking.
2. *Machined* conventional 5-barrel hinge.

ALSO Ensembler

A graceful women's fashion frame. The only fine frame with interchangeable jewels especially to accent the colors of all fashion accessories.

SIZES	Eye 44, 46, 48; Bridge 20, 22, 24, 26, (Standard Boxing Dimensions); Temples 4", 4¼", 4½", 4¾", 5" L. B.
COLORS	(Clear Bridge) Slate blue/crystal and black/crystal with white temples, mocha/crystal with pink temples; (Solid) Black with white temples, mocha and demi-amber with pink temples.
	Use Masculon, Westbury or Mansfield Square shaper. End piece and temples 1/10 12 K. Gold Filled, pink or white.

Command Performance T.M. FRAMES

UNIVIS

THE UNIVIS LENS COMPANY / Dayton

New York, Chicago, Los Angeles, San Francisco

COMMAND PERFORMANCE FRAMES • MASCULON • ENSEMBLER

Distinctively Styled FOR PATIENT ACCEPTANCE

NO. 200 CASES BY SHURON

Color . . . inside and outside . . . is the key to the popularity of Shuron's No. 200 cases.

They're modernly styled, in a variety of contrasting linings and fashionable color and texture combinations . . . acceptable to both men and women.

Aluminum shell, light and compact . . . gives positive protection. Colorfast covering materials, won't check or crack . . . easily imprinted. Snap buttons add a smart dash of color.

Order from your Independent Optical Supply House.

SHURON OPTICAL COMPANY, INC., GENEVA, N.Y.

On the advice of leading fashion stylists, Shuron has added two new stunning and dynamic colors to the No. 200 Case line . . . Charcoal Medina and White Fleece . . . distinctively gay for Spring.

T-200-1

10 SMART TEXTURE AND COLOR BLENDS

Skiver Grain . . . Red, Blue, Ginger, Cordovan, Saddle Tan.
Krinkle . . . Green.
Tweed . . . Blue.
Twillitex.
Medina . . . Charcoal.
Fleece . . . White.

REDUCES CASE INVENTORY

The No. 200 Case accepts practically all types of frames and mountings.

SHURON